

## **Appendix C**

### *Ferns and Allies*

## SPECIES ACCOUNT: *Adenophorus periens* (Pendant kihi fern)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

#### **Physical Description**

A fern with pendulous fronds 10 - 40 cm long and 1 - 3 cm wide that taper at each end (NatureServe, 2015). The fronds have slightly hairy stalks less than 1 centimeter (0.4 inch) long. Each frond is comprised of oblong or narrowly triangular pinnae (divisions or leaflets) 5 to 15 millimeters (0.2 to 0.6 inch) long with margins that are smooth or toothed and lined with sparse hairs (USFWS, 1999).

#### **Taxonomy**

A member of the grammitis family (Grammitidaceae). It was not formally described until 1974, when L. Earl Bishop published the name *Adenophorus periens*. Prior to its description, the names *Polypodium adenophorus* and *Adenophorus pinnaefidus* had been erroneously applied to the species represented by Beechey's specimen (Bishop 1974) (USFWS, 1999).

#### **Historical Range**

It historically occurred on the islands of Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii (USFWS 1994; USFWS, 2015).

#### **Current Range**

Currently, it is only found on the islands of Kauai and Hawaii (Plant Extinction Prevention Program [PEPP] 2015) (USFWS, 2015).

#### **Critical Habitat Designated**

Yes; 2/27/2003.

#### **Legal Description**

On March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Adenophorus periens* (Pendant Kihī fern) in Maui County, Hawaii (81 FR 17789 - 18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Adenophorus periens* (Pendant kihi fern) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 critical habitat units (CHUs), on Oahu in Honolulu County, Hawaii (77 FR 57648 - 57862).

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

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Adenophorus periens* (Pendant Kihī fern) on the island of Kauai, Hawaii (68 FR 9116 - 9214).

On March 18, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Adenophorus periens* on Molokai.

#### **Critical Habitat Designation**

Maui—Montane Wet—Unit 1, Maui—Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui—Montane Wet—Unit 4, and Maui—Montane Wet—Unit 5 constitute critical habitat for *Adenophorus periens* on Maui. Molokai—Montane Wet—Unit 1, Molokai—Montane Wet—Unit 2, and Molokai—Montane Wet—Unit 3 constitute critical habitat for *Adenophorus periens* on Molokai.

Maui—Montane Wet—Unit 1. This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2. This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and

space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3. This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4. This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5. This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and

canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units area occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1. This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. profuga*, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 1 is not known to be occupied by *Adenophorus periens*, *Cyanea procera*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2. This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. Although Molokai—Montane Wet—Unit 2 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Melicope reflexa*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and

recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3. This unit consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Adenophorus periens* includes 14 CHUs in Honolulu County, Hawaii (77 FR 57648-57862).

Oahu—Lowland Wet—Unit 6 (and) Blackline Hawaiian Damselfly—Unit 1—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 1—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 2—Lowland Wet This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. This area is occupied by the plant *Hesperomannia arborescens* and by the blackline and oceanic Hawaiian damselflies, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline and oceanic Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *Lobelia oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum*

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

Oahu—Wet Cliff—Unit 6 (and) Crimson Hawaiian Damselfly—Unit 12— Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 13—Lowland Wet This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. This area includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem, and the unique features identified as PCEs for the Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the crimson and oceanic Hawaiian damselflies are dispersed in the wet cliff ecosystem, the wet cliff ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area is occupied by the plants *Cyanea crispa*, *Huperzia nutans*, *Pteralyxia macrocarpa*, and *Schiedea kaalae*, and by the oceanic Hawaiian damselfly. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce deppeana*, *C. rockii*, *Cyanea acuminata*, *C. calycina*, *C. humboldtiana*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra kaulantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Lysimachia filifolia*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Psychotria hexandra* ssp. *oahuensis*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, or *Viola oahuensis*, or by the crimson Hawaiian damselfly, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 7 (and) Blackline Hawaiian Damselfly—Unit 2—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 2—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 3—Lowland Wet This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). This unit is occupied by the plants *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. humboldtiana*, *C. purpurellifolia*, *C. truncata*, *Cyrtandra viridiflora*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Myrsine juddii*, *Phyllostegia hirsuta*, *Platydesma cornuta* var. *cornuta*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Tetraplasandra gymnocarpa*, *Viola oahuensis*, and *Zanthoxylum oahuense*, and by the blackline and oceanic Hawaiian damselflies. This area includes the wet forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline and oceanic Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species

because they provide for the proper ecological functioning of this ecosystem. The streams, foraging areas, and cover areas that are occupied contain the essential PCEs, and the streams and upland areas that are not occupied are essential to the conservation of the species because they support the proper ecological functioning of the occupied areas within the ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Cyanea crispa*, *C. grimesiana* ssp. *grimesiana*, *C. koolauensis*, *C. lanceolata*, *C. st.-johnii*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. waiolani*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Phyllostegia parviflora*, *Plantago princeps*, *Platanthera holochila*, *Psychotria hexandra* ssp. *oahuensis*, *Sanicula purpurea*, or *Trematolobelia singularis*, or by the crimson Hawaiian damselfly, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 7 (and) Crimson Hawaiian Damselfly—Unit 13— Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 14—Lowland Wet This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem, and the unique features identified as PCEs for the crimson and oceanic Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the crimson and oceanic Hawaiian damselflies are dispersed in the wet cliff ecosystem, the wet cliff ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area is occupied by the plants *Cyanea crispa*, *Psychotria hexandra* ssp. *oahuensis*, and *Schiedea kaalae*, and by the crimson and oceanic Hawaiian damselflies. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce deppeana*, *C. rockii*, *Cyanea acuminata*, *C. calycina*, *C. humboldtiana*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra kaulantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *Huperzia nutans*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Lysimachia filifolia*, *Phyllostegia hirsuta*, *P. parviflora*, *P. princeps*, *Pteralyxia macrocarpa*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, or *Viola oahuensis*, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 8 (and) Blackline Hawaiian Damselfly—Unit 3—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 3—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 4—Lowland Wet This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and

Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. This area is occupied by the plant *Cyrtandra kaulantha*, and by the invertebrates, the blackline and crimson Hawaiian damselflies. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline and crimson Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the oceanic Hawaiian damselfly, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 8 (and) Crimson Hawaiian Damselfly—Unit 14— Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 15—Lowland Wet This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem, as well as unique for the species PCEs for the crimson and oceanic Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the crimson and oceanic Hawaiian damselflies are dispersed in the wet cliff ecosystem, the wet cliff ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area is occupied by the plants *Cyanea acuminata*, *C. calycina*, *C. humboldtiana*, *C. purpurellifolia*, *C. st.-johnii*, *Cyrtandra kaulantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *Huperzia nutans*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Lysimachia filifolia*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, and *Viola oahuensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce deppeana*, *C. rockii*, *Cyanea crispa*, *C. truncata*, *Psychotria hexandra* ssp. *oahuensis*, or *Schiedea kaalae*, or by the crimson and oceanic Hawaiian damselflies, we have determined this area to be essential for

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

Oahu—Lowland Wet—Unit 9 (and) Blackline Hawaiian Damselfly—Unit 4—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 4—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 5—Lowland Wet This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream, and is occupied by the plants *Chamaesyce rockii*, *Cyanea calycina*, *C. humboldtiana*, *C. koolauensis*, *C. st.-johnii*, *Cyrtandra viridiflora*, *Gardenia mannii*, *Hesperomannia arborescens*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platydesma cornuta* var. *cornuta*, *Pteris lidgatei*, *Tetraplasandra gymnocarpa*, *Viola oahuensis*, and *Zanthoxylum oahuense*, and by the blackline and crimson Hawaiian damselflies. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline and crimson Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Cyanea acuminata*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. purpurellifolia*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. waiolani*, *Huperzia nutans*, *Isodendron longifolium*, *Lobelia gaudichaudii* ssp. *koolauensis*, *Myrsine juddii*, *Platanthera holochila*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Sanicula purpurea*, or *Trematolobelia singularis*, or by the oceanic Hawaiian damselfly, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 10 (and) Blackline Hawaiian Damselfly—Unit 5—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 5—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 6—Lowland Wet This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the blackline Hawaiian damselfly (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the

lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 11 (and) Blackline Hawaiian Damselfly—Unit 6—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 6—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 7—Lowland Wet This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. This area is occupied by the blackline and oceanic Hawaiian damselflies, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline and oceanic Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to these damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson Hawaiian damselfly, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 12 (and) Blackline Hawaiian Damselfly—Unit 7—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 7—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 8—Lowland Wet This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for this Hawaiian damselfly (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 13 (and) Blackline Hawaiian Damselfly—Unit 8—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 8—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 9—Lowland Wet This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for this Hawaiian damselfly (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*,

*Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 14 (and) Blackline Hawaiian Damselfly—Unit 9—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 9—Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 10—Lowland Wet This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. This area is occupied by the plant, *Cyanea koolauensis*, and by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselfly (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 15 (and) Blackline Hawaiian Damselfly—Unit 10—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 10— Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 11—Lowland Wet This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. This area is occupied by the plant, *Cyanea crispa*, and by the blackline

Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselfly (see Tables 4 and 5). Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 16 (and) Blackline Hawaiian Damselfly—Unit 11—Lowland Wet (and) Crimson Hawaiian Damselfly—Unit 11— Lowland Wet (and) Oceanic Hawaiian Damselfly—Unit 12—Lowland Wet This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge. This area is occupied by the plants *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. st.-johnii*, *Cyrtandra gracilis*, *C. polyantha*, *C. sessilis*, *Gardenia mannii*, *Hesperomannia aborescens*, *Platydesma cornuta* var. *cornuta*, *Sanicula purpurea*, and *Tetraplasandra gymnocarpa*. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselfly (see Tables 4 and 5). This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea grimesiana* ssp. *grimesiana*, *C. purpurellifolia*, *C. truncata*, *Cyrtandra dentata*, *C. kaulantha*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the blackline, crimson or oceanic Hawaiian damselflies, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it

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

The critical habitat designation for *Adenophorus periens* includes one unit totaling 6,754 acres in Hawaii County, Hawaii. The unit is Hawaii 28—*Adenophorus periens*—a.

Hawaii 28—*Adenophorus periens*—a [2,733 ha (6,754 ac)]: This unit straddles the Kaahakini and Kilauea watersheds, and lies completely within the Kahaulea NAR. The unit provides habitat for 1 population of 300 mature, reproducing individuals of *A. periens*, and is currently occupied by an unknown number of individuals. This unit is essential to the conservation of *A. periens* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population. This unit is geographically separated from other critical habitat for this multiisland species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

The critical habitat designation for *Adenophorus periens* includes four units totaling 5,447 acres on Kauai. The units are Kauai 4—*Adenophorus periens*—a, Kauai 10—*Adenophorus periens*—b, and Kauai 11—*Adenophorus periens*—c, d.

Kauai 4—*Adenophorus periens*—a: This unit is critical habitat for *Adenophorus periens* and is 237 ha (585 ac) on State (Alakai Wilderness Preserve and Kealia, and Moloaa Forest Reserves) and private land. The unit contains a portion of Waioli and Limahuli Valleys, Ke Ana Kolea and Kahili, Kekoiki, Lelewi, Mount Namahana, and Puu Eu Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial *Adenophorus periens* and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations on the island from being destroyed by one naturally occurring catastrophic event.

Kauai 10—*Adenophorus periens*—b: This unit is critical habitat for *Adenophorus periens* and is 492 ha (1,215 ac) on State (Lihue-Koloa Forest Reserve) and private land. The unit contains a portion of Kalalau Valley, Limahuli Valley, Kanaele Swamp, and Hulua, Kahili, and Kapalaoa Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Adenophorus periens* and is currently occupied with 50 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations on the island from being destroyed by one naturally occurring catastrophic event.

Kauai 11—*Adenophorus periens*—c: This unit is critical habitat for *Adenophorus periens* and is 469 ha (1,160 ac) on State (Halelea Forest Reserve) and private land. The unit contains a portion

of Kalalau and Limahuli Valleys, Waiopa, and Kaliko, Namolokama Mountain, and Puu Manu Summits, and. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Adenophorus periens* and is currently occupied with two plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations on the island from being destroyed by one naturally occurring catastrophic event. Kauai 11—*Adenophorus periens*—d: This unit is critical habitat for *Adenophorus periens* and is 1,007 ha (2,487 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. The unit contains a portion of Kalalau and Limahuli Valleys, and Hono o Na Pali, Keanapuka, Moaalele, Pali Eleele, and Pihea Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Adenophorus periens* and is currently occupied with six plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations on the island from being destroyed by one naturally occurring catastrophic event.

The critical habitat designation for *Adenophorus periens* includes three units totaling 2,233 acres on Molokai, Maui county, Hawaii. The units are Molokai 6—*Adenophorus periens*—a, b, c.

Molokai 6—*Adenophorus periens*—a: This unit is critical habitat for *Adenophorus periens* and is 79 ha (194 ac) on State (Puu Alii NAR) and private land and contains a portion of the eastern ridge of Waikolu Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Adenophorus periens* and is currently unoccupied. In addition, it is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Molokai 6—*Adenophorus periens*—b This unit is critical habitat for *Adenophorus periens* and is 396 ha (980 ac) on State (Molokai Forest Reserve) and private land. The unit contains a portion of Kaholoapele, Kamakou, Pakui, Puu o Wahaula, and Uapa Summits, and Kalapa, Konomanu, and Kuana Ridges. This unit provides habitat for 2 populations of 300 mature, reproducing individuals of the short-lived perennial *Adenophorus periens* and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary to the establishment of additional populations on Molokai in order to reach recovery goals. In addition, it is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Molokai 6—*Adenophorus periens*—c This unit is critical habitat for *Adenophorus periens* and is 214 ha (530 ac) on State (Molokai Forest Reserve and Olokui NAR) and private land. The unit contains a portion of Kapapa Pali, Olokui and Pohakuulaula Summits. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Adenophorus periens* and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary to the establishment of additional populations on Molokai in order to reach recovery goals. In addition, it is some distance away

from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

**Primary Constituent Elements/Physical or Biological Features**

In units Maui—Montane Wet—Unit 1, Maui—Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui—Montane Wet—Unit 4, and Maui—Montane Wet—Unit 5, the physical and biological features of critical habitat are:

- (i) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m).
- (ii) Annual precipitation: Greater than 75 in (190 cm).
- (iii) Substrate: Well-developed soils, montane bogs.
- (iv) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros.
- (v) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine.
- (vi) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

In units Molokai—Montane Wet—Unit 1, Molokai—Montane Wet—Unit 2, and Molokai—Montane Wet—Unit 3, the physical and biological features of critical habitat are:

- (i) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m).
- (ii) Annual precipitation: Greater than 75 in (190 cm).
- (iii) Substrate: Well-developed soils, montane bogs.
- (iv) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros.
- (v) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine.
- (vi) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Adenophorus periens* critical habitat consists of two components (Lowland wet and wet Cliff). Species known historically (last observed > 20 yrs ago) from indicated ecosystem in the Koolau Mountain caldera complex (77 FR 57648-57862):

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

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia,

Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Habitat features essential for the conservation of the species includes, but is not limited to, Metrosideros polymorpha or Ilex anomala, or possibly other native trees large enough to support epiphytic growth of this species, in Metrosideros polymorpha-Cibotium glaucum lowland wet forest.

Within the Kauai units (Kauai 4, 10, 11c, and 11d), the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) On Metrosideros polymorpha trunks, in riparian banks of stream systems in well-developed, closed canopy that provides deep shade or high humidity in Metrosideros polymorpha-Cibotium glaucum lowland wet forests, open Metrosideros polymorpha montane wet forest, or Metrosideros polymorpha-Dicranopteris linearis lowland wet forest and containing one or more of the following native plant species: Antidesma platyphyllum, Athyrium sandwichianum, Broussaisia arguta, Cheirodendron trigynum, Cyanea spp., Cyrtandra spp., Dicranopteris linearis, Freycinetia arborea, Hedyotis terminalis, Labordia hirtella, Machaerina angustifolia, Psychotria spp., Syzygium sandwicensis, or Tetraplasandra oahuensis; and

(ii) Elevations between 169 and 1,345 m (553 and 4,411 ft).

The habitat features contained in these units that are essential for this species include, but are not limited to, Metrosideros polymorpha trunks in M. polymorpha-Cibotium glaucum lowland wet forest and cloud forests in well-developed, closed canopy, providing deep shade and high humidity.

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species includes habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of this species will continue to be degraded and destroyed.

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur

(Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., “sustained yield”) in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses *Andropogon* sp. and *Setaria* sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D’Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., *Schiedea attenuata*). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

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

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

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

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

Not available.

### ***Life History***

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: Unknown - probably outbreeding (USFWS, 1999)

**Breeding Season**

Adult: Year round (USFWS, 1999)

**Reproduction Narrative**

Adult: Its breeding system is unknown but outbreeding is very likely to be the predominant mode of reproduction. Due to the weak differences between the seasons, there seems to be no evidence of seasonality in growth or reproduction (USFWS, 1999).

**Habitat Type**

Adult: Terrestrial - arboreal, riparian (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Lowland wet forest, montane wet forest (USFWS, 2010)

**Dependencies on Specific Environmental Elements**

Adult: High humidity (USFWS, 1999)

**Habitat Narrative**

Adult: Growing on trees in wet forests (NatureServe, 2015). *Adenophorus periens* is epiphytic, most often on *Metrosideros polymorpha*. On Kauai, it is found along riparian banks of stream systems in well-developed, closed canopy that provides deep shade and high humidity in *Metrosideros polymorpha* - *Cibotium glaucum* lowland wet forests, open *M. polymorpha* montane wet forest, or *M. polymorpha* - *Dicranopteris linearis* (uluhe) lowland wet forest (USFWS 1999) (USFWS, 2010). *Adenophorus periens* seems to grow only in closed canopy dense forest with high humidity (USFWS, 1999).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Spores are dispersed by wind, possibly by water, and perhaps on the feet of birds or insects (Linney 1989) (USFWS, 1999).

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Decreasing (USFWS, 2015)

**Resiliency:**

Low (inferred from USFWS, 2015; see current range/distribution)

**Representation:**

High (USFWS, 2010)

**Redundancy:**

Moderate (inferred from USFWS, 2010)

**Number of Populations:**

12 (USFWS, 2010)

**Population Size:**

~31 (USFWS, 2015)

**Population Narrative:**

Extremely high genetic variability in this species is thought to be an adaptation to existing in isolated populations where it relies on its own mutations, rather than gene flow from neighboring populations to persist (Ranker 1994) (USFWS, 2010). Based on the best available information provided, the number of individuals has decreased from the approximately 31 to 123 wild individuals reported in the previous 5- year review to approximately 31 wild individuals in 2015 (USFWS, 2015).

***Threats and Stressors***

**Stressor:** Volcanic activity (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Ranker suggested that volcanic activity, including direct impacts of flowing lava and noxious gases emitted from the volcano, might be a considerable threat to this species on the island of Hawaii, as its only known population is on the east flank of the Kilauea volcano, which remains active (Ranker 1994). During 2007 and 2008 the Kahaualea Natural Area Reserve has been closed due to threatened eruptions of the volcano (Ten Bruggencate 2007) (USFWS, 2010).

**Stressor:** Nonnative species (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The population in Kahaualea Natural Area Reserve on the island of Hawaii is threatened by feral pigs (*Sus scrofa*) and cattle (*Bos taurus*) which damage the vegetation, as well as competition with invasive introduced plant species (Hawaii Division of Forestry and Wildlife 1992). On Kauai, non-native feral ungulates such as pigs, goats (*Capra hircus*), and mule deer (*Odocoileus hemionus*) are a serious threat to the watershed and the species' habitat. Some very aggressive introduced plant species are invasive throughout the area including *Clidemia hirta* (Koster's curse), *Sphaeropteris cooperi* (Australian tree fern), *Psidium guajava* (guava), *Hedychium gardnerianum* (kahili ginger), *Erigeron karvinskianus* (daisy fleabane), and *Buddleia asiatica* (dog tail) (Wood 2007) (USFWS, 2010).

***Recovery*****Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

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

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

**Delisting Criteria:**

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

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

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

**Recovery Actions:**

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect against feral ungulates (USFWS, 1999).
- Develop a volcanic hazard contingency plan (USFWS, 1999).
- Maintain adequate genetic stock and reestablish the plant in its historic range (USFWS, 1999).
- Control alien plants (USFWS, 1999).
- Conduct/encourage research into the reasons for its decline (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).

***Conservation Measures and Best Management Practices:***

- Captive propagation for genetic storage and reintroduction – Collect genetic resources for storage, propagation, and reintroduction into protected suitable habitat within the species' historical range (USFWS, 2015).
- Invasive plant monitoring and control – Continue control of invasive introduced plant species within the exclosure (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals (USFWS, 2015).
- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosure (USFWS, 2015).

- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2015).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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## SPECIES ACCOUNT: *Adiantum vivesii* (No Common Name)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; Proposed for delisting

### **Physical Description**

This is a gregarious colonial fern with creeping, nodose 2.5- to 3-millimeter (mm)-thick rhizomes. The fronds are distichous and erect-spreading, approximately 0.5 centimeters (cm) apart and 45 to 71 cm long. The stipes or stalks are lustrous purple-black, 25 to 46 cm long, irregularly branched, and have hairlike scales. The frond's blades are broad and irregular, 20 to 28 cm long, and 23 to 35 cm broad. The rachis and costae are more densely covered with hairlike scales than the stipe. The blades have 2 or 3 alternate or occasionally subopposite pinnae, with a larger terminal pinnae. These are lance oblong, 13 to 20 cm long, and 3.5 to 5 cm broad. The terminal pinna may be up to 7 cm broad, and is stalked and often somewhat inequilateral. Each pinna has 10 to 13 pairs of alternate, narrowly oblong-falcate pinnules, which are unequally cuneate at base. The outer sterile margins of the pinna are irregularly serrulate, and the tissue is dull green on both sides. Five elliptic to linear sori are borne along the basal half of the acroscopic margin. The sori are close or contiguous, but remain distinct. The indusoid is gray-brown, turgid, with an erose margin (Proctor 1989). (USFWS, 1994)

### **Taxonomy**

Sepulveda-Orengo (2000) conducted morphometric analysis of *Adiantum vivesii* and *Adiantum tetraphyllum* based on 21 vegetative characters and one spore character. She also conducted chromosome counts; light microscopy observations of fresh or dried pinnules, and sporangia of *Adiantum vivesii* and *Adiantum tetraphyllum*; and scanning electron microscopy (SEM) studies on rhizomes, fertile pinnules and spores. In the morphometric analysis she found significant differences between *Adiantum vivesii* and *Adiantum tetraphyllum* for 16 of the vegetative characters as well as spore size, concluding that *Adiantum vivesii* appears to be a distinct morphological taxon. (USFWS, 2008)

### **Historical Range**

Not Available

### **Current Range**

It is known from only one population in a privately-owned limestone hill in Quebradillas, Puerto Rico. Proctor (1991) estimated 1,000 plants, or growing apices, at the locality. Sepulveda-Orengo (2000) located and measured the extent of the population, finding an area of 21m x 10m (68.9 ft. x 32.8 ft.). (USFWS 2008)

### **Critical Habitat Designated**

Yes;

### **Life History**

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: Asexual (USFWS, 2008)

**Reproduction Narrative**

Adult: This species appears to be sterile. The plant uses the rhizome for its vegetative reproduction (USFWS, 2008).

**Habitat Type**

Adult: Terrestrial (USFWS, 1994)

**Habitat Vegetation or Surface Water Classification**

Adult: Subtropical moist forest (USFWS, 1994)

**Dependencies on Specific Environmental Elements**

Adult: High moisture (inferred from USFWS, 1994)

**Habitat Narrative**

Adult: This species is found in the limestone or karst region of northwestern Puerto Rico. It occurs within the semi-evergreen seasonal forests of the subtropical moist forest life zone (Ewel and Whitmore 1973), in a deeply shaded hollow at the base of a limestone hill in Quebradillas (USFWS, 1994).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: No information available.

***Population Information and Trends*****Population Trends:**

One individual (USFWS, 2008)

**Species Trends:**

Sterile hybrid (USFWS, 2008)

**Resiliency:**

Very low (inferred from USFWS, 2008)

**Representation:**

Very low (inferred from USFWS, 2008)

**Redundancy:**

Very low (inferred from USFWS, 2008)

**Number of Populations:**

0 (USFWS, 2008)

**Population Size:**

1 (USFWS, 2008)

**Population Narrative:**

The species status is stable, based on the 2005 - 2007 Recovery Data Call. It appears that the population is one individual with rhizome proliferations and is not a valid species, but a sterile hybrid (USFWS, 2008).

**Threats and Stressors**

**Stressor:**

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The threats identified in the recovery plan are no longer relevant to this species (USFWS, 2008).

**Recovery****Reclassification Criteria:**

1. The known populations are placed under protective status (USFWS, 2008).
2. An agreement between the Service and the DNER concerning the protection of the three species in Commonwealth forests has been developed and implemented (USFWS, 2008).
3. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 2008).

**Delisting Criteria:**

Recommend Delisting based on species being a sterile hybrid (USFWS, 2018).

**Recovery Actions:**

- Prevent further habitat loss and population decline (USFWS, 1994).
- Continue to gather information on the distribution and abundance of the seven endangered ferns (USFWS, 1994).
- Conduct research on habitat requirements, reproductive biology, and ecology of the seven species (USFWS, 1994).
- Establish new populations (USFWS, 1994).
- Refine recovery goals (USFWS, 1994).

**Conservation Measures and Best Management Practices:**

- Not available - the Service recommends delisting since *A. vivesii* does not appear to be a valid species, capable of sexual reproduction.

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## **SPECIES ACCOUNT: *Asplenium dielerectum* (=Diellia erecta) (Asplenium-leaved diellia)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

A fern with a short stem. The fronds are once-divided, and 20 - 70 cm long (NatureServe, 2015).

### **Taxonomy**

A member of the spleenwort family (Aspleniaceae) (USFWS, 1999). Kartesz (1994, 1999) treats *Diellia erecta* and *D. laciniata* as distinct species; Wagner (1993) recognized *D. laciniata* as a variant of *D. erecta*. In Wagner et al. (2012), *Asplenium dielerectum* (*Diellia erecta*), *Asplenium diellaciniatum* (*Diellia laciniata*), and *Asplenium dielpallidum* (*Diellia pallida*) are each recognized as distinct species. *Diellia* is no longer recognized as distinct from *Asplenium* (Wagner et al. 2012) (NatureServe, 2015).

### **Historical Range**

It is historically known from Kauai, Oahu, Molokai, Maui, Lanai, and Hawaii (Palmer 2003) (USFWS, 2015).

### **Current Range**

Currently the species occurs on Kauai, Oahu, Molokai, and Maui (USFWS, 2015).

### **Critical Habitat Designated**

Yes; 2/27/2003.

### **Legal Description**

On March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Asplenium dielerectum*.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Asplenium dielerectum* (=Diellia erecta) on the island of Kauai (68 FR 9116 - 9479).

September 18, 2012, the U.S. Fish and Wildlife Service (Service) revised critical habitat for *Asplenium dielerectum* (=Diellia erecta) on the island of Oahu.

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

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Asplenium dielerectum* (=Diellia erecta) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Asplenium dielerectum* (=Diellia erecta) (77 FR 57648-57862). The critical habitat designation includes 4 critical habitat units, which encompass approximately 1,939 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Asplenium dielerectum* (=Diellia erecta) includes areas that were determined by the Service to be occupied at the time of listing, and also includes

unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

### Critical Habitat Designation

Maui—Lowland Dry—Unit 5, Maui—Lowland Dry—Unit 6, Maui—Lowland Mesic—Unit 2, Maui—Lowland Mesic—Unit 3, Maui—Lowland Wet—Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, Maui—Lowland Wet—Unit 8, and Maui—Montane Mesic—Unit 1 constitute critical habitat for *Asplenium dielerectum* on Maui. Molokai—Lowland Mesic—Unit 1, Molokai—Lowland Wet—Unit 1, Molokai—Lowland Wet—Unit 2, Molokai—Lowland Wet—Unit 3, and Molokai—Montane Mesic—Unit 1 constitute critical habitat for *Asplenium dielerectum* on Molokai.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, the Service has determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Zanthoxylum hawaiiense*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for

the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by *Asplenium dielirectum*, *Bidens campylotheca* ssp. *pentamera*, or *Colubrina oppositifolia*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants *Asplenium dielirectum*, *Bidens campylotheca* ssp. *pentamera*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, or by the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea*

*glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Maui—Lowland Wet—Unit 6 consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Maui—Lowland Wet—Unit 8 consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia*

bracteata, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

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

Molokai—Lowland Wet—Unit 1 consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant *Cyrtandra filipes*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units also contain unoccupied habitat that is essential to the

conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 1 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant *Lysimachia maxima*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Lowland Wet—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by *Asplenium dielerectum*, *Bidens wiebkei*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea dunbariae*, *C. grimesiana* ssp. *grimesiana*, *C. solanacea*, *Cyrtandra filipes*, *Lysimachia maxima*, *Melicope reflexa*, *Peucedanum sandwicense*, *Phyllostegia hispida*, *P. mannii*, *Plantago princeps*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Bidens wiebkei*, *Santalum haleakalae* var.

lanaiense, and *Spermolepis hawaiiensis*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Mesic—Unit 1 is not known to be occupied by *Asplenium dielirectum*, *Cyanea dunbariae*, *C. mannii*, *C. procera*, *C. solanacea*, *Cyperus fauriei*, *Kadua laxiflora*, *Melicope mucronulata*, *Neraudia sericea*, *Plantago princeps*, or *Stenogyne bifida*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Asplenium dielirectum* includes one unit totaling 901 acres in Kauai County, Hawaii. The unit is Kauai 11—*Diellia erecta*—a.

Kauai 11—*Diellia erecta*—a [364 ha (901 ac)]: This unit is critical habitat for *Diellia erecta* and is 365 ha (901 ac) on State land (Alakai Wilderness Preserve) containing portions of Kawaiiki Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Diellia erecta* and is currently occupied with 30 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

The critical habitat designation for *Asplenium dielirectum* (= *Diellia erecta*) includes 1,939 acres on Oahu. The units are Oahu—Lowland Mesic—Unit 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not occupied by *Asplenium dielirectum* (= *Diellia erecta*), the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 5: consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. This unit includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not occupied by *Asplenium dielirectum* (= *Diellia erecta*), the Service has determined this area to be essential for

the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 6: This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Although this unit is not occupied by *Asplenium dielerectum* (=Diellia erecta), the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 7 consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge. This unit is occupied by *Asplenium dielerectum* (=Diellia erecta) and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations.

The critical habitat designation for *Asplenium dielerectum* (=Diellia erecta) includes two units totaling 4,806 acres in Hawaii county, Hawaii. The units are Hawaii 17—Diellia erecta—a and Hawaii 18—Diellia erecta—b. Both units currently are occupied. Each unit is essential to the conservation of *D. erecta* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The units are geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The two critical habitat units designated for *D. erecta* in this rule provide habitat for a total of two populations, each with 300 mature, reproducing individuals.

Hawaii 17—Diellia erecta—a [329 ha (814 ac)]: This unit contains no named natural features, it lies completely within the Kiilae watershed, and is also completely within the South Kona Forest Reserve; provides habitat for one population of 300 individuals of *D. erecta*; and is currently occupied by 22 individuals.

Hawaii 18—Diellia erecta—b [1,615 ha (3,992 ac)]: This unit contains no named natural features, it lies completely within the Kauna watershed, and is also completely within the Manuka NAR; provides habitat for 1 population of 300 individuals of *D. erecta*; and is currently occupied by 2 individuals. This unit provides the southernmost critical habitat within the species' historical range.

The critical habitat designation for *Asplenium dielerectum* (=Diellia erecta) includes 4 critical habitat units, covering one ecosystem type, which encompasses approximately 1,939 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

### Primary Constituent Elements/Physical or Biological Features

(i) In units Maui—Lowland Dry—Unit 5 and Maui—Lowland Dry—Unit 6, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Less than 50 in (130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

(ii) In units Maui—Lowland Mesic—Unit 2 and Maui—Lowland Mesic—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

(iii) In units Maui—Lowland Wet—Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, and Maui—Lowland Wet—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

(iv) In unit Maui—Montane Mesic—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

(i) In unit Molokai—Lowland Mesic—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia,

Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

(ii) In units Molokai—Lowland Wet— Unit 1, Molokai—Lowland Wet—Unit 2, and Molokai—Lowland Wet—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

(iii) In unit Molokai—Montane Mesic—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

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

(i) Brown granular soil with leaf litter and occasional terrestrial moss on north-facing slopes in deep shade on steep slopes or gulch bottoms in Metrosideros polymorpha-Dicranopteris linearis wet forest or Metrosideros polymorpha mixed mesic forest with Acacia koa and Acacia koaia as codominants and containing one or more of the following native plant species: Asplenium aethiopicum, Asplenium contiguum, Asplenium macraei, Coprosma spp., Dodonaea viscosa, Dryopteris fusco-atra, Dryopteris unidentata, Hedyotis terminalis, Leptecophylla tameiameia, Melicope spp., Microlepia strigosa, Myrsine spp., Nestegis sandwicensis, Psychotria spp., Syzygium sandwicensis, or Wikstroemia spp.; and

(ii) Elevations between 655 and 1,224 m (2,149 and 4,016 ft).

Within these units, the physical and biological features of critical habitat are:

(i) Elevation: Less than 3,300 ft (1,000 m).

(ii) Annual precipitation: 50 to 75 in (130 to 190 cm).

(iii) Substrate: Shallow soils, little to no herbaceous layer.

(iv) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum.

(v) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax.

(vi) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Habitat features that are essential for this species include, but are not limited to, Metrosideros polymorpha-Nestegis sandwicensis lowland mesic forest.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Asplenium dielirectum* (=Diellia erecta) critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Asplenium dielirectum* (=Diellia erecta) occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. Lowland Mesic. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of this species will continue to be degraded and destroyed.

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

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and

goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to Oahu— Lowland Mesic— Unit 3 and Oahu— Lowland Mesic—Unit 7.

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

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

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Asplenium dielerectum* (= *Diellia erecta*) to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

### ***Life History***

#### **Food/Nutrient Resources**

#### **Lifespan**

Adult: < 10 years (USFWS, 2009)

#### **Reproduction Narrative**

Adult: *Diellia erecta* is a short-lived perennial (fewer than ten years) (USFWS, 2009).

#### **Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Moist forests and shrublands, lava flow (NatureServe, 2015); Lama/ohia lowland mesic forest (USFWS, 1999)

**Geographic or Habitat Restraints or Barriers**

Adult: 700 - 5,200 ft. elevation (USFWS, 1999)

**Habitat Narrative**

Adult: Inhabits moist forests and shrublands on gulch slopes. On the island of Hawaii it grows in moist forests on old rough lava flows (NatureServe, 2015). *Diellia erecta* is found in Lama/Ohia Lowland Mesic Forest at elevations between 210 and 1,590 meters (700 and 5,200 feet) (HPCC 1995; USFWS 1996b; R. Warshauer, in /ztt. 1996) (USFWS, 1999).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Declining (USFWS, 2015)

**Resiliency:**

Low (inferred from USFWS, 2015)

**Redundancy:**

Moderate (inferred from USFWS, 2015)

**Number of Populations:**

10 (USFWS, 2015)

**Population Size:**

57 - 67 (USFWS, 2015)

**Population Narrative:**

Overall, the numbers of individuals have decreased from the approximately 100 wild individuals reported in the previous 5-year review to approximately 57 to 67 wild individuals in 2015 (USFWS 2012a; USFWS 2012b; PEPP 2011, 2013). There are 3 populations on Kauai, one on Oahu, 2 on Molokai, and 4 on Maui (USFWS, 2015).

***Threats and Stressors***

**Stressor:** Herbivory (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Herbivory by slugs (*Derocerus* species) has been reported as a threat to this species on Maui and Oahu (PEPP 2009) (USFWS, 2015).

**Stressor:** Nonnative species (USFWS, 2009)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** On Kauai, *Diellia erecta* f. *alexandri* is threatened with habitat degradation by feral pigs and goats and competition with introduced invasive plant species such as *Blechnum occidentale* (hammock fern), *Cyperus meyenianus* (Meyen's flatsedge), *Gravillea robusta* (silk oak), *Lantana camara* (lantana), *Morella faya* (firetree), *Passiflora tarminiana* (banana poka), *Rubus argutus* (blackberry) and/or *Setaria palmifolia* (palmgrass) (USFWS 2003b). Habitat disturbance by feral pigs has been noted to affect the population at Kawai Iki (Agurauja 2005). On Oahu, the main threats are habitat degradation by feral pigs, competition with invasive introduced species such as *Blechnum appendiculatum*, *Clidemia hirta* (Koster's curse), *Cordyline fruticosa* (ti), *Oplismenus hirtellus* (basketgrass), *Phymatosorus grossus* (maile scented fern), *Psidium cattleianum* (strawberry guava), *Schinus terebinthifolius* (Christmas berry) and *Schefflera actinophylla* (octopous tree) (USFWS 2003e). On Molokai, threats include habitat degradation by feral pigs, goats, and axis deer; and competition with invasive introduced plant species such as *Blechnum occidentale*, *Fraxinus uhdei* (tropical ash), *Lantana camara*, *Melinis minutiflora* (Molasses grass), *Psidium cattleianum*, and *Ricinus communis* (castorbean) (Factor E (USFWS 1994, 1999, 2003c). Habitat at Puu Kolekole, Molokai has been reduced due to trampling and browsing by goats (Agurauja 2005). On Maui, the taxon is threatened by habitat degradation caused by feral pigs, goats and cattle; and competition with introduced invasive plant species. The life-span of fronds is reduced by the activities of introduced insects (*Heliothrips haemorrhoidalis*) (Agurauja 2005) (USFWS, 2009).

**Stressor:** Stochastic events (USFWS, 2009)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Drought and erosion impacts the growth and survival of the mature *Diellia erecta* individuals. Fire is now considered to be a threat for this taxon as the one plant at Polipoli (Kula Forest Reserve) was adversely affected by a large fire in early 2007 (USFWS, 2009).

## **Recovery**

### **Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

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

**Delisting Criteria:**

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

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

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

**Recovery Actions:**

- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).

***Conservation Measures and Best Management Practices:***

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2015).
- Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range (USFWS, 2015).
- Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions (USFWS, 2015).
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants (USFWS, 2015).
- Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals (USFWS, 2015).
- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures (USFWS, 2015).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).

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## **SPECIES ACCOUNT: *Asplenium dielfalcatum* (= *Diellia falcata*) (No common name)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

A fern with a short stem. Fronds are once divided, and 20 - 100 cm long (NatureServe, 2015). It grows from a rhizome 1 to 5 cm (0.4 to 2 in) long and 0.5 to 2 cm (0.2 to 0.8 in) in diameter, which is covered with small black or maroon scales. This species is distinguished from others in the genus by the color and texture of its leaf stalk, the venation pattern of its fronds, the color of its scales, its rounded and reduced lower pinnae (leaflets), and its separate sori (spore clusters) arranged on marginal projections (Palmer 2003; Makua Implementation Team 2003) (USFWS, 2016).

### **Taxonomy**

A member of the Aspleniaceae family (USFWS, 2016). Genus endemic to Hawaiian islands, species endemic to Oahu. W.H. Wagner (1952) stated that this is the most clear-cut species in the genus (NatureServe, 2015).

### **Historical Range**

Historically, *Diellia falcata* was known from almost the entire length of the Waianae Mountains, from Manini Gulch to Palehua Iki, as well as from the Koolau Mountains of Oahu, from Kaipapau Valley to Aiea Gulch (USFWS, 2016).

### **Current Range**

Currently, *D. falcata* is locally common in the Waianae Range, but it is probably extirpated from the Koolau Range (USFWS, 2016).

### **Critical Habitat Designated**

Yes; 6/17/2003.

### **Legal Description**

On September 18, 2012, the U.S. Fish and Wildlife Service designated critical habitat for *Asplenium dielfalcatum*.

### **Critical Habitat Designation**

Oahu—Lowland Mesic—Unit 1, Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu—Lowland Mesic—Unit 4, Oahu—Lowland Mesic—Unit 5, Oahu—Lowland Mesic—Unit 6, Oahu—Lowland Mesic—Unit 7, Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8 constitute critical habitat for *Diellia falcata* on Oahu.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately

owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. superba*, *Cyrtandra dentata*, *Delissea subcordata*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua degeneri*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *S. nuttallii*, *S. obovata*, and *Viola chamissoniana* ssp. *chamissoniana*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Lowland Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Cyanea calycina*, *C. grimesiana* ssp. *obatae*, *Delissea subcordata*, *Diellia falcata*, *Gardenia mannii*, *Phyllostegia hirsuta*, *P. kaalaensis*, *P. mollis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *Solanum sandwicense*, *Stenogyne kanehoana*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonioides*, *Delissea subcordata*, *Diellia falcata*, *D. unisora*, *Hesperomannia arbuscula*, *Melicope saint-johnii*, *Phyllostegia mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *Silene perlmannii*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although Oahu—Lowland Mesic—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*,

*Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *C. truncata*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Gardenia mannii*, *Hesperomannia arborescens*, *Isodendrion laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *S. nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

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

Oahu—Lowland Mesic—Unit 6 consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. This area is occupied by the plants *Cyanea acuminata*, *C. crispa*, *C. truncata*, *Gardenia mannii*, *Pteralyxia macrocarpa*, and *Schiedea kaalae*; and the invertebrate, the oceanic Hawaiian damselfly. This area includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem, as well as unique PCEs for the damselfly. Because the streams and upland foraging and cover areas required by the oceanic Hawaiian damselfly are dispersed in the lowland mesic ecosystem, the lowland mesic ecosystem's physical or biological features are essential to the damselfly because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not known to be occupied by the plants *Alectryon macrococcus*, *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Ctenitis squamigera*, *Cyanea calycina*, *C.*

*grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. longiflora*, *Cyrtandra dentata*, *C. polyantha*, *Delissea subcordata*, *Diellia erecta*, *D. falcata*, *Eugenia koolauensis*, *Hesperomannia arborescens*, *Isodendron laurifolium*, *I. longifolium*, *Kadua coriacea*, *Labordia cyrtandrae*, *Lobelia monostachya*, *Melicope lydgatei*, *M. saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Schiedea nuttallii*, *Solanum sandwicense*, *Tetraplasandra gymnocarpa*, or *T. lydgatei*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

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

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

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

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

Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *Silene lanceolata*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also

contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

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

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

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

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

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

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

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

#### **Primary Constituent Elements/Physical or Biological Features**

(i) In units Oahu—Lowland Mesic—Unit 1, Oahu—Lowland Mesic—Unit 2, Oahu—Lowland Mesic—Unit 3, Oahu—Lowland Mesic—Unit 4, Oahu—Lowland Mesic—Unit 5, Oahu—Lowland Mesic—Unit 6, and Oahu—Lowland Mesic—Unit 7, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*

(ii) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: *Antidesma*, *Chamaesyce*, *Diospyros*, *Dodonaea*. (F) Understory: *Bidens*, *Eragrostis*, *Melanthera*, *Schiedea*.

#### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas.

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

Adult: Sexual (USFWS, 2016)

**Lifespan**

Adult: < 10 years (USFWS, 2011)

**Breeding Season**

Adult: Year round (USFWS, 2016)

**Reproduction Narrative**

Adult: Fronds bearing sori (spores) have been observed year-round (Service 1998b). *Diellia falcata* hybridizes with *D. unisora* to form an endemic hybrid *D. lauii* which was described as locally common when found by J. Lau in 1991 (USFWS, 2016). *Asplenium dielfalcatum* is a short-lived perennial (< 10 years) (USFWS, 2011).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Dryland forest (NatureServe, 2015); diverse mesic forest (USFWS, 2016)

**Dependencies on Specific Environmental Elements**

Adult: Deep shade or open understory (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 735 - 3,126 ft. elevation (USFWS, 2016)

**Habitat Narrative**

Adult: In soil in deep shade or open understory, dryland forest. (NatureServe, 2015). *Diellia falcata* is a terrestrial fern that typically grows in deep shade or open understory on moderate to moderately steep slopes and gulch bottoms in diverse mesic forest between 224 and 953 m (735 and 3,126 ft) elevation. Typically, *Diella* sp. is restricted to spatially fragmented habitat type on the steep sides of gulches. Plants grow on soil that is rocky, granular and usually dry, with some leaf litter and mosses (Agurauja 2001) (USFWS, 2016).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

### ***Population Information and Trends***

**Population Trends:**

Not available

**Resiliency:**

Very low (inferred from USFWS, 2016; see current range/distribution)

**Redundancy:**

Moderate (inferred from USFWS, 2016)

**Number of Populations:**

15 (USFWS, 2011)

**Population Size:**

5,540 - 6,540 (USFWS, 2016)

**Minimum Viable Population Size:**

50 mature, reproducing individuals (USFWS, 2016)

**Population Narrative:**

According to the status as summarized in the Endangered Species Mitigation Plan (Service 1999b) from the Makua Biological Assessment, *D. falcata* is known from 22 populations with between 5,540 to 6,540 individuals. There are at least three populations outside the Makua and Oahu action areas with more than 50 mature, reproducing individuals, the minimum number suggested for stabilization populations for this species (U.S. Army Garrison 2005) (USFWS, 2016). There are 15 known populations with thousands of individuals (USFWS, 2011).

### ***Threats and Stressors***

**Stressor:** Feral ungulates (USFWS, 1998; 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Species such as *Diellia falcata* have been detrimentally affected by the activities of cattle (USFWS 1995). Because of past restrictions on hunting, widespread ranching, and ineffective confinement of the animals, cattle populations boomed and spread to many parts of the island (Culliney 1988). The impact of cattle on native vegetation is similar to that described for goats (Cuddihy and Stone 1990, Scott et al. 1986, Tomich 1986). It was not until local land managers recognized the extent of the destruction of native vegetation by these animals that their numbers were controlled. However, by then much of the plant cover on cattle-grazing land on Oahu and other islands was already degraded (USFWS, 1998). Feral pigs (*Sus scrofa*) and goats (*Capra hircus*) disturb the ground and significantly contribute to erosion, and together represent the single greatest threat to this species (USFWS, 2011).

**Stressor:** Herbivory (USFWS, 2016)

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

**Narrative:** Greenhouse thrips (*Heliethrips haemorrhoidalis*) have been observed on these plants and in one case approximately 10 percent of the population were damaged (Aguraiuja 2001) (USFWS, 2016). Goats and rats (*Rattus* spp.) are believed to eat these ferns (Perlman 2009) (USFWS, 2011).

**Stressor:** Nonnative plants (USFWS, 1998)

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

**Narrative:** Alien plants compete with natives for space, light, water, and nutrients (Cuddihy and Stone 1990). The most significant aliens appear to be *Schinus terebinthifolius* (Christmas berry), *Psidium cattleianum* (strawberry guava), *Melinis minutiflora* (molasses grass), *Clidemia hirta* (Koster's curse), *Lantana camara* (lantana), *Leucaena leucocephala* (koa haole), *Rubus argutus* (prickly Florida blackberry), *Grevillea robusta* (silk oak), *Erigeron karvinskianus* (daisy fleabane), *Myrica faya* (firetree), *Paspalum conjugatum* (Hilo grass), *Casuarina equisetifolia* (common ironwood), *Passiflora suberosa* (huehue haole), *Ageratina adenophora* (Maui pamakani), *Ageratina riparia* (Hamakua pamakani), *Kalanchoe pinnata* (air plant), *Tibouchina herbacea* (a relative of Koster's curse), and *Ardisia elliptica* (shoebutton ardisia). (USFWS 1995, 1996a, 1996b) (USFWS, 1998).

**Stressor:** Fire (USFWS, 1998)

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

**Narrative:** Not available

**Stressor:** Climate change (USFWS, 2011)

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

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

**Recovery****Reclassification Criteria:**

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

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

**Delisting Criteria:**

1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

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

**Recovery Actions:**

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosures to protect populations against feral ungulates (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1988).
- Provide protection from fire (USFWS, 1998).
- Conduct research into additional limiting factors (USFWS, 1998).
- Conduct genetic/taxonomic research (USFWS, 1998).
- Maintain adequate genetic stock (USFWS, 1998).

***Conservation Measures and Best Management Practices:***

- Approximately 1,338 individuals (20 percent) of this species occur in Kahanahaiki Management Unit where they benefit from population unit and/or ecosystem-level protection such as ungulate fencing (USFWS, 2016).
- *Diellia falcata* is represented in an ex situ collection of spores in micropropagation (Harold L. Lyon Arboretum) (Service 2005b) (USFWS, 2016).
- Monitor all populations and determine the current status of the species; survey to determine numbers of mature individuals in each population (USFWS, 2011).
- Fence remaining populations to protect against the negative impacts from feral ungulates (USFWS, 2011).
- Control invasive introduction of plant species around all populations (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Develop and implement an effective method to control greenhouse thrips (USFWS, 2011).
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy (USFWS, 2011).
- Collect material for genetic storage and propagation for reintroduction (USFWS, 2011).
- Work with Hawaii Division of Forestry and Wildlife, U.S. Navy, Hawaii State Parks, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).

- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).

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USFWS. 2011. *Diellia falcata* (no common name) 5-Year Review Short Form Summary. Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawaii.

## **SPECIES ACCOUNT: *Asplenium diellaciniatum* (Kauai) (Cutleaf Island-spleenwort)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

This fern, a terrestrial or epipetric (growing on rocks) fern, has extremely variable frond morphology, depending on age, development, and possibly microhabitat (Wood and Agurauja, pers. obs. in Lorence et al. 2013, p. 167). Stipes (stalks joining the stem to the blade) and rachis (blade midribs) are black or purple-black to maroon and shiny. Blade divisions are entire to shallowly or deeply cut into lobes or twice divided, with free veins that seldom join to form a vein network (Lorence et al. 2013, p. 170) (USFWS, 2015).

### **Taxonomy**

A member of the spleenwort family (Aspleniaceae). Hillebrand (1888, pp. 621–622) recognized this species as *Lindsaya laciniata*. Brackenridge also interpreted *Diellia* as *lindsaeoid* (ferns having morphological characteristics of those in the genus *Lindsaea*), followed by other Hawaiian authors, and this fern was described as *Diellia laciniata* in Rock and in Wagner. Palmer did not recognize *D. laciniata* as separate from *D. erecta*. Molecular phylogenetic studies by Schneider et al. (2005) placed *Diella* within *Asplenium*, and with further taxonomic reassessment (Lorence et al. 2013), this species is recognized as *Asplenium diellaciniatum* (USFWS, 2015). A synonym is *Diellia laciniata*-(Hbd.) Diels (NatureServe, 2015).

### **Historical Range**

Little is known of the historical distribution of this species (USFWS, 2015).

### **Current Range**

Known from western Kauai (USFWS, 2015).

### **Critical Habitat Designated**

No;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproduction Narrative**

Adult: Not available

### **Habitat Type**

Adult: Terrestrial (USFWS, 2016)

### **Habitat Vegetation or Surface Water Classification**

Adult: Montane mesic forest (USFWS, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: 500 - 1,700 m elevation (NatureServe, 2015)

**Habitat Narrative**

Adult: This fern is found in the montane mesic ecosystem (USFWS, 2015). Terrestrial habitat is characterized as forest. It usually occurs on cinder rocks or loamy soil in dry to mesic forests, 500 - 1700m (Palmer 2003) (NatureServe, 2015).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Declining (USFWS 2015)

**Resiliency:**

Very low (inferred from USFWS, 2016; see historical range/distribution)

**Redundancy:**

Very low (inferred from USFWS, 2016)

**Number of Populations:**

3 (USFWS, 2016)

**Population Size:**

100 (USFWS, 2016)

**Population Narrative:**

There are 3 occurrences, totaling approximately 100 individuals 30 of which are in an ungulate exclosure (USFWS, 2016).

***Threats and Stressors***

**Stressor:** Habitat degradation or destruction (USFWS, 2015; USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Feral pigs, goats, and black-tailed deer (*Odocoileus hemionus columbianus*) modify and destroy the habitat of *Asplenium diellaciniatum* on Kauai, with evidence of the activities of these animals reported in the areas where *A. diellaciniatum* occurs (HBMP 2010; Wood 2013, in litt.). Nonnative plants in the Kawaiiki area, such as *Buddleja asiatica* (dog tail), *Lantana camara* (lantana), and *Sphaeropteris cooperi* (Australian tree fern), compete with *A. diellaciniatum* and

modify and destroy its native habitat, and displace it and other native Hawaiian plant species by competing for water, nutrients, light, and space, or they may produce chemicals that inhibit growth of other plants (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74; Wood 2013, in litt.) (USFWS, 2015; USFWS, 2016).

**Stressor:** Herbivory (USFWS, 2015; USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Feral pigs (*Sus scrofa*), goats (*Capra hircus*), and black-tailed deer (*Odocoileus hemionus columbianus*) may forage on *A. diellaciniatum* (HBMP 2010) Ungulates are managed in Hawaii as game animals, but public hunting does not adequately control the numbers of ungulates to eliminate habitat modification and destruction or herbivory by these animals (USFWS, 2016).

**Stressor:** Small population size (USFWS, 2015; USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The small number of individuals of *A. diellaciniatum* may limit this species' ability to adapt to environmental change (USFWS, 2015; USFWS, 2016).

### ***Recovery***

**Reclassification Criteria:**

Not available

**Delisting Criteria:**

Not available

**Recovery Actions:**

- Not available

### ***Conservation Measures and Best Management Practices:***

- Not available

### **References**

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

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Proposed Rule. 80 Federal Register 189. September 30, 2015. Pages 58819 - 58909

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U.S. Fish and Wildlife Service. 2015. Endangered Status for 49 Species From the Hawaiian Islands.

## SPECIES ACCOUNT: *Asplenium dielmannii* (= *Diellia mannii*) (No common name)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

A fern with a slightly curved rhizome. Fronds are very finely dissected, and 15 - 85 cm long (NatureServe, 2015).

### **Taxonomy**

A member of the asplenium family (Aspleniaceae) (USFWS, 2010a). Genus endemic to Hawaiian islands, derived from *Asplenium Leucostegioides*. Species endemic to Kauai (NatureServe, 2015).

### **Historical Range**

Historically known from one location in the Halemanu area of what is now Kokee State Park, in the northwestern region of Kauai (USFWS, 2010a).

### **Current Range**

Currently occurs in the Waimea region, Kauai (NatureServe, 2015).

### **Critical Habitat Designated**

Yes; 4/13/2010.

### **Legal Description**

On April 13, 2010, the U.S. Fish and Wildlife Service designated critical habitat for *Diellia mannii* under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Kauai County in Hawaii (75 FR 18960-19165).

### **Critical Habitat Designation**

Kauai 11—*Diellia mannii*—a, Kauai 21— *Diellia mannii*—b, and Kauai 22—*Diellia mannii*—c constitute critical habitat for *Diellia mannii* on Kauai.

Kauai—Montane Mesic—Section 1. Montane Mesic—Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR. The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Labordia helleri*, *Myrsine knudsenii*, *Platydesma rostrata*, *Psychotria grandiflora*, *Stenogyne kealiae*, and *Tetraplasandra flynnii*. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1—Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1—Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in

the montane mesic ecosystem, as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, *Cheirodendron* sp. and *Tetraplasandra* sp.). Although Montane Mesic–Section 1 is not known to be occupied by the species *Diellia mannii*, *Myrsine mezii*, and the akikiki, the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2. Montane Mesic–Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge. The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by *Diellia mannii* and the picture-wing fly *Drosophila sharpi*, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem, as well as the larval-stage host plants (*Cheirodendron* sp. and *Tetraplasandra* sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations.

#### **Primary Constituent Elements/Physical or Biological Features**

Within the critical habitat units, the primary constituent elements of critical habitat are:

- (i) Elevation: 3,000 to 5,243 ft (914 to 1,598 m).
- (ii) Annual precipitation: 50 to 75 inches (127 to 190 centimeters).
- (iii) Substrate: Weathered aa lava flows, rocky mucks, thin silty loams, deep volcanic ash soils.
- (iv) Canopy: *Acacia*, *Metrosideros*, *Psychotria*, *Tetraplasandra*, *Zanthoxylum*.
- (v) Subcanopy: *Cheirodendron*, *Coprosma*, *Kadua*, *Ilex*, *Myoporum*, *Myrsine*.
- (vi) Understory: *Bidens*, *Dryopteris*, *Leptecophylla*, *Poa*, *Scaevola*, *Sophora*.

#### **Special Management Considerations or Protections**

The primary threats to the physical and biological features essential to the conservation of all this species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas.

#### ***Life History***

#### **Food/Nutrient Resources**

#### **Reproduction Narrative**

Adult: Not available

**Habitat Type**

Adult: Terrestrial (USFWS, 2010a)

**Habitat Vegetation or Surface Water Classification**

Adult: Montane mesic forest (USFWS, 2010a)

**Geographic or Habitat Restraints or Barriers**

Adult: ~3,450 ft. elevation (USFWS, 2010a)

**Habitat Narrative**

Adult: It is found on a northwest-facing slope just above a gulch bottom in what was likely *Acacia koa* (*koa*)–*Metrosideros polymorpha* dominated montane mesic forest in the past, but which is now a forest dominated by the nonnative *Corynocarpus laevigatus* (*karakanut*) in the montane mesic ecosystem, at an elevation of 3,450 ft. (1,050 m) (Agurauja and Wood 2003, p. 155; HBMP 2007; TNCH 2007) (USFWS, 2010a).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Presumed extinct in 1900s (USFWS, 2010a)

**Species Trends:**

Rediscovered in 2002 (USFWS, 2010a)

**Resiliency:**

Very low (inferred from NatureServe, 2015; see current range/distribution)

**Representation:**

Very low (inferred from USFWS, 2010a)

**Redundancy:**

Very low (inferred from USFWS, 2010a)

**Number of Populations:**

1 (USFWS, 2010a)

**Population Size:**

1 (USFWS, 2010a)

**Population Narrative:**

The species was thought to be extinct since the early 1900s, until 2002 when a single individual was rediscovered (Agurauja and Wood 2003, pp. 154– 155; Palmer 2003, p. 120). Currently, the species is known only from this one individual in the southeastern branch of Nawaimaka Stream in the Halemanu Mountains of Kokee State Park (HBMP 2007) (USFWS, 2010a).

### ***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Adverse impacts on habitat of this species have been identified from non-native plants, pigs, deer, fire, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Fire can destroy dormant seeds and plants, even in steep in inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants.

**Stressor:** Predation and herbivory (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Predation and herbivory by nonnative animal species present an immediate and significant threat to *Diellia mannii* throughout its range due to documented browsing and trampling by pigs, goats, and deer (USFWS, 2010).

**Stressor:** Small populations (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Diellia mannii* is known from only one individual in the wild. Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

### ***Recovery***

**Reclassification Criteria:**

Not available

**Delisting Criteria:**

Not available

**Recovery Actions:**

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010b).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010b).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010b).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010b).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010b).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010b).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010b).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010b).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010b).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010b).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010b).

**Conservation Measures and Best Management Practices:**

- The Plant Extinction Prevention Program focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010b).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Captive propagation for genetic storage and reintroduction—Collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation— o Augment current natural populations to increase numbers of individuals. o Reintroduce individuals into

suitable habitat within historic range that is being managed for known threats to the species to establish new populations. • Invasive plant monitoring and control— o Continue control of invasive introduced plant species within the vicinity of all known fenced and unfenced individuals. o Control ecosystem-altering nonnative invasive plant species within Kawaiiki-KoaieHalemanu area. • Ungulate monitoring and control—Construct an enclosure for second population and for reintroductions to exclude black-tailed deer, pigs, and goats, and retrofit current enclosure to exclude black-tailed deer. • Surveys and inventories—Continue surveys for populations of *A. dielmanni* in areas of potentially suitable habitat. • Population viability and monitoring and analysis—o Continue to monitor the wild populations. o Study the populations and any reintroductions to determine viable population size and structure, geographical distribution, pollination vectors, spore dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future taking into consideration the impacts of climate change. • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. • Based on the recovery criteria above, consider development of a recovery plan. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms (USFWS, 2017).

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## SPECIES ACCOUNT: *Asplenium dielpallidum* (=Diellia pallida) (No common name)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 2/25/1994; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

A fern that grows in tufts of three to four light green, lance-shaped fronds along with a few persistent dead ones, and reproduces by spores, the minute, reproductive dispersal unit of ferns and fern allies. This short-lived perennial species differs from others of this endemic Hawaiian genus by the color and sheen of the midrib, the presence and color of scales on the midrib, and the frequent fusion of sori (a group or cluster of spore cases) (Wagner 1952, 1987) (USFWS, 2003)

### **Taxonomy**

A member of the spleenwort family (Aspleniaceae) (USFWS, 1995). Published by W.H. Wagner, Jr. in Contributions from the Michigan Herbarium, Vol. 19: 63-82, 1993, and recognized by Kartesz (1999). Genus endemic to Hawaiian Islands, species endemic to Kauai. Closest relative to this species is *D. falcata* of Oahu. In the past, the name *D. laciniata* had been misapplied to this species (NatureServe, 2015).

### **Historical Range**

Known historically from Halemanu on Kauai (Hillebrand 1888) (USFWS, 2008).

### **Current Range**

Currently, there are three populations totaling seven mature individuals, 10 juvenile individuals, and 24 sporelings (PEPP 2014, 2016) (USFWS, 2017).

### **Critical Habitat Designated**

Yes; 2/27/2003.

### **Legal Description**

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

### **Critical Habitat Designation**

The critical habitat designation for *Asplenium dielpallidum* (=Diellia pallida) includes two CHUs in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—Diellia pallida—a: This unit is critical habitat for Diellia pallida and is 602 ha (1,487 ac) on State land (Kuia NAR). This unit contains portions of Kuia and Mahanaloa Valleys, and Milolii Ridge. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Diellia pallida and is currently occupied with between 38 and 43 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this

species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, bare granular soil with dry to mesophytic leaf litter with a pH of 6.9 to 7.9 on steep slopes in lowland mesic forest. This unit is geographically separated from the other unit designated as critical habitat for this islandendemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. This fern species has windblown spores with limited opportunity for germination and growth. Therefore, this species requires large intact areas of land to support a viable population.

Kauai 11—*Diellia pallida*—b: This unit is critical habitat for *Diellia pallida* and is 55 ha (136 ac) on State land within Koaie Canyon. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Diellia pallida* and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, bare granular soil with dry to mesophytic leaf litter with a pH of 6.9 to 7.9 on steep slopes in lowland mesic forest. This unit is geographically separated from the other unit designated as critical habitat for this islandendemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. This fern species has windblown spores with limited opportunity for germination and growth. Therefore, this species requires large intact areas of land to support a viable population.

#### **Primary Constituent Elements/Physical or Biological Features**

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

- (i) Brown soil with basalt outcrops near waterfalls in lowland or montane mesic *Metrosideros polymorpha*-*Acacia koa* forest; and
- (ii) Elevations between 624 and 1,234 m (2,048 and 4,048 ft).

#### **Special Management Considerations or Protections**

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

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

Adult: < 10 years; up to 35+ years, 2.6 years average (USFWS, 2008)

**Breeding Season**

Adult: Year round; primarily May - June (USFWS, 2008)

**Reproduction Narrative**

Adult: It is a short-lived perennial (fewer than 10 years). Recent observations of natural populations of *Diellia pallida* (Agurauja 2005) showed that transformation from sporeling stage into premature stage may take place within 6 to 12 months depending on microhabitat and local weather conditions. The observations showed that if protected and in favorable microhabitat conditions, this species may reach maturity within five years. Estimates based on observations of natural populations and experiments show that about one percent of the population could live more than 35 years, with average lifespan for mature plants of 23.2 years. However, the overall life span of individuals under current conditions in the wild is only 2.6 years, mainly due to high sporeling mortality (Agurauja et al. 2005). Although the ferns with spore-producing fronds could be found all year around, maximum spore release is still seasonal, following the wet season (May through June) (USFWS, 2008).

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Lowland mesic forest, mixed montane mesic forest (USFWS, 2008)

**Dependencies on Specific Environmental Elements**

Adult: 30 - 75 degree northern slopes, 70 - 90% canopy cover (USFWS, 2008)

**Geographic or Habitat Restraints or Barriers**

Adult: 1,970 - 2,460 ft. elevation (USFWS, 2008)

**Habitat Narrative**

Adult: Inhabits moist forests on gulch slopes (NatureServe, 2015). *Diellia pallida* is a species of the Kauai Diverse Lowland Mesic Forest and Mixed Mountain Mesic Forest communities. *Diellia pallida* is currently restricted to a spatially-fragmented habitat type on the steep sides of gulches. Plants occur on northern slopes at elevations between 600 and 750 meters (1,970 and 2,460 feet), on slopes varying from gentle to steep (30 to 75 degrees). This species grows on bare granular soil with dry to mesophytic leaf litter with a pH of 6.9 to 7.9, where soil moisture content is halved from February to June. Ground cover in current habitat is very sparse (one to 25 percent). However, *D. pallida* prefers the shade of canopy and under story shrubs, with coverage usually 70 to 90 percent (National Tropical Botanical Gardens 2006) (USFWS, 2008).

***Dispersal/Migration***

**Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Rediscovered in 1988 (USFWS, 2008)

**Resiliency:**

Very low (inferred from USFWS, 1995; see current range/distribution)

**Redundancy:**

Low (inferred from USFWS, 2008)

**Number of Populations:**

3 (USFWS, 2008)

**Population Size:**

12 mature (USFWS, 2008)

**Population Narrative:**

The species had not been seen since 1949 until a collection was made in 1988 in Puu Ka Pele Forest Reserve (USFWS 1994). Since then, several other populations were discovered, but from seven populations known in 1947 to 1949 (Wagner 1952), only three populations currently remain, totaling 12 mature individuals (USFWS 1994; Aguraiuja 2005) (USFWS, 2008).

***Threats and Stressors***

**Stressor:** Ungulate disturbance (USFWS, 2008 and 1995)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Results in predation and habitat degradation by feral goats, feral pigs and mule deer (USFWS, 2008 and 1995).

**Stressor:** Invasive plants (USFWS, 2008 and 1995)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Competition (lantana, Melia azedarach (Chinaberry), St. Augustine grass, Oplismenus hirtellus (basketgrass), kukui and ti) (USFWS, 1995).

**Stressor:** Stochastic events (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The low number of individuals left in the wild makes the species vulnerable to stochastic events, such as hurricanes and landslides. The species is also threatened by erosion and fire (USFWS 1994 and 1995) (USFWS, 2008).

**Stressor:** Climate Change

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Asplenium dielpallidum* is highly vulnerable to the impacts of climate change, with a score of 0.954 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). This species was determined to have to overlap between current and future climate envelopes, and is unlikely to easily tolerate expected changes in climate. This limitation means that *A. dielpallidum* must either endure in suitable microrefugia within its current climate envelope, or move to newly available climatecompatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future.

## ***Recovery***

### **Reclassification Criteria:**

1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

### **Delisting Criteria:**

1. A total of 8 to 10 populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1995).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1995).

### **Recovery Actions:**

- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).

- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).
- Devise and implement a public education program (USFWS, 1995).
- Propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately (USFWS, 1995).
- Protection of remaining wild individuals from mule deer, feral goats, feral pigs and alien weed threats (USFWS, 1995).

***Conservation Measures and Best Management Practices:***

- Continue spore collection for genetic storage (USFWS, 2008).
- Fence individual plants outside of proposed or already fenced areas for short-term protection from ungulates (USFWS, 2008).
- Control introduced invasive plant species around remaining plants: in Kuia, *Kalanchoe pinnata*, *Adiantum hispidulum* (rough maidenhair fern), *Blechnum appendiculatum* (no common name (NCN)); in the eastern part of Mahanaloa Valley, *Kalanchoe pinnata*, *Adiantum hispidulum* (rough maidenhair fern), *Blechnum appendiculatum* (NCN), *Oplismenus hirtellus* (basketgrass); in the western part of Mahanaloa Valley *Kalanchoe pinnata*, *Adiantum hispidulum* (rough maidenhair fern), *Blechnum appendiculatum* (NCN) (USFWS, 2008).
- Survey for populations in known historical sites and suitable habitat (USFWS, 2008).
- Augment populations as plants become available in nurseries (USFWS, 2008).
- Reintroduce individuals into suitable habitat within historical range that is being managed for the known threats to this species (USFWS, 2008).
- Continue monitoring of population condition and additional research on the breeding system both in experimental and natural conditions (USFWS, 2008).
- Genetic research to determine genetic composition of remaining population and whether to mix sources for reintroduced populations (USFWS, 2008).
- Recommendations for Future Actions: No significant new information regarding the species' biological status has come to light since the last 5-year review in 2008. Thus, the following recommendations for future actions are reiterated for 5-year review for 2017. • Surveys and inventories—Survey for populations in known historical sites and suitable habitat. • Ungulate monitoring and control—Maintain and monitor fenced populations. • Invasive plant monitoring and control—Control ecosystem-altering nonnative invasive plant species around all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect and propagate individuals for outplanting into suitable habitat with historic range that is being managed for known threats to this species. • Rodent herbivory—Implement effective control methods for rodents. • Invertebrate herbivory—Determine the level of threat from invertebrate herbivory and the need for additional recovery actions. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals through historic range to reduce impacts of low viability (USFWS, 2017).

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## **SPECIES ACCOUNT: *Asplenium peruvianum* var. *insulare* (= *Asplenium fragile insulare*) (No common name)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 09/26/1994; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

*Asplenium fragile* var. *insulare* is a fern in the Aspleniaceae, or spleenwort family. It is a perennial plant that is delicate, small to medium-sized and terrestrial. The rhizomes are decumbent and 3 to 12 millimeters (0.1 to 0.5 inch) in diameter. The fronds are 15 to 46 centimeters (6 to 18 inches) long and 1 to 3 centimeters (0.4 to 1.2 inches) wide. The fronds are often proliferous with one to many proliferations on the upper stipes and lower rachises. It can be differentiated from other *Asplenium* in Hawaii by its habitat; its narrow, long-linear, pale green fronds; dull gray or brown stipes with two greenish ridges on the upper surface; and occasional one to many plantlets on the upper stipes and lower rachises (Palmer 2003).

### **Historical Range**

*Asplenium fragile* var. *insulare* was known historically from East Maui and from the island of Hawaii. Historically, the species was present on east Maui, recorded from the north slope of Haleakala and on Kanahau Hill (U.S. Army 2003a). On the island of Hawaii, A. f. var. *insulare* was found at Kalaieha, Laumaia, Keanakolu and Umikoa on Mauna Kea, Puu Waawaa on Hualalai, west Keawewai, above Kipuka Ahiu on Mauna Loa, and near Hilo.

### **Current Range**

Currently on Maui there are two occurrences with 18 individuals found in Kalialinui within the East Maui Watershed Partnership. On the island of Hawaii, A. f. var. *insulare* is currently found in 17 occurrences with more than 600 individuals. There are 13 occurrences in the Pohakuloa Training Area, one in Hawaii Volcanoes National Park, two just south of the Upper Waiakea Forest Reserve and the Mauna Loa Forest Reserve, and one occurrence in the Keokea section of the South Kona District (68 FR 25934; 68 FR 39624).

### **Critical Habitat Designated**

Yes; 5/14/2003.

### **Legal Description**

March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Asplenium fragile insulare*.

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Asplenium fragile insulare* on the island of Hawaii.

### **Critical Habitat Designation**

Maui—Montane Wet—Unit 1, Maui— Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui—Montane Wet— Unit 4, Maui—Montane Wet—Unit 5, Maui—Montane Mesic—Unit 1, Maui— Subalpine—Unit 1, and Maui— Subalpine—Unit 2 constitute critical habitat for *Asplenium peruvianum* var. *insulare* on Maui.

Maui—Montane Wet—Unit 1. This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2. This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3. This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and

understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, *kiwiku* (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the *akohekohe* (*Palmeria dolei*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4. This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5. This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plant *Bidens campylotheca* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp.

waihoiensis, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1. This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1. This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed hermland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem. They are occupied by the plants *Bidens micrantha* ssp. *kalealaha* and *Geranium arboreum*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium peruvianum* var. *insulare*, *Geranium multiflorum*, *Phyllostegia bracteata*, *Schiedea haleakalensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers

of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2. This area consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, and *Schiedea haleakalensis*, and by the forest bird, the akohekohe (*Palmeria dolei*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 2 is not known to be occupied by the plants *Asplenium peruvianum* var. *insulare*, *Bidens micrantha* ssp. *kalealaha*, *Geranium arboreum*, *Phyllostegia bracteata*, or *Zanthoxylum hawaiiense*, or by the forest bird, the kiwiku (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat for *Asplenium peruvianum* var. *insulare* (= *Asplenium fragile insulare*) includes one unit totaling 2,241 acres in Hawaii county, Hawaii. The unit is Hawaii 24—*Asplenium fragile* var. *insulare*—a.

Hawaii 24—*Asplenium fragile* var. *insulare*—a [907 ha (2,241 ac)]: The unit contains no named natural features and lies in the Pahala watershed, mostly in Kapapala Forest Reserve, with the southern point in Kau Forest Reserve. This unit provides habitat for 1 population of 300 mature, reproducing individuals of *A. fragile* var. *insulare* and is currently occupied by 11 individuals. This unit is essential to the conservation of *A. fragile* var. *insulare* because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. This unit provides the southernmost critical habitat within the species' historical range. This unit is geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

#### **Primary Constituent Elements/Physical or Biological Features**

(i) In units Maui—Montane Wet—Unit 1, Maui—Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui—Montane Wet—Unit 4, and Maui—Montane Wet—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*. (E) Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*. (F) Understory: Ferns, *Carex*, *Coprosma*, *Leptecophylla*, *Oreobolus*, *Rhynchospora*, *Vaccinium*.

(ii) In unit Maui—Montane Mesic—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: *Acacia*, *Ilex*, *Metrosideros*, *Myrsine*, *Nestegis*, *Nothocestrum*, *Pisonia*, *Pittosporum*, *Psychotria*, *Sophora*,

Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

(iii) In units Maui—Subalpine—Unit 1 and Maui—Subalpine—Unit 2, the physical and biological features of critical habitat are: (A) Elevation: 6,500 to 9,800 ft (2,000 to 3,000 m). (B) Annual precipitation: 15 to 40 in (38 to 100 cm). (C) Substrate: Dry ash; sandy loam; rocky, undeveloped soils; weathered lava. (D) Canopy: Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. (E) Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. (F) Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

Habitat features essential for this species includes, but is not limited to, Metrosideros polymorpha dry montane forest, Dodonaea viscosa dry montane shrubland, Myoporum sandwicense-Sophora chrysophylla dry montane forest, and Metrosideros polymorpha-Acacia koa forest, as well as subalpine dry forest and shrubland.

This species grows almost exclusively in large, moist lava tubes (from 3 to 4.5 m (10 to 15 ft) in diameter), pits, deep cracks, and lava tree molds, with at least a moderate soil or ash accumulation, associated with mosses and liverworts.

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of this species will continue to be degraded and destroyed.

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

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

### **Life History**

**Food/Nutrient Resources****Reproduction Narrative**

Adult: Reproductive cycles, longevity, specific environmental requirements, and limiting factors are unknown. No gametophytes (gamete-producing life stage) have been found, and the age-class structure of the sublocations sampled at the Pohakuloa Training Area on Hawaii was determined to be 100 percent reproductive adults (U.S. Army 2003a; 68 FR 25934).

**Habitat Type**

Adult: Lava tubes/mesic to dry subalpine shrubland

**Habitat Narrative**

Adult: On Maui, *Asplenium fragile* var. *insulare* is found within streamside hollows and grottoes that occur in mesic to dry subalpine shrubland dominated by *Leptecophylla tameiameiae* and *Sadleria cyatheoides*, with scattered *Metrosideros polymorpha*. *Asplenium fragile* var. *insulare* has also been observed in montane wet ohia forest in rocky gulches in association with other fern species. *Asplenium fragile* var. *insulare* has been observed at elevations between 1,682 and 2,407 meters (5,518 and 7,897 feet). On the island of Hawaii *Asplenium fragile* var. *insulare* grows in moist and dark areas in large lava tubes, pits, and deep cracks on varying ages of lava that have moderate soil or ash accumulation, and is associated with mosses and liverworts. The species can occasionally be found growing in the interface between young aa and older pahoehoe lava flow deposits. At the Pohakuloa Training Area, the species is found in sparse or open *Metrosideros* Treeland, with shrub understory, *Myoporum*-*Dodonaea* or *Myoporum*-*Sophora* Shrublands, *Sophora*-*Myoporum*-*Chamaesyce* Shrubland, and *Leptecophylla*-*Dodonaea* Shrubland. Associated native plant species include *Dryopteris wallichiana*, and *Grammitis hookeri* (U.S. Army 2003a). Plants are frequently found growing in white mineral deposits of caves without any soil or ash accumulation.

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

Unknown

**Population Size:**

~600

**Population Narrative:**

On the island of Hawaii, *A. f.* var. *insulare* was found at Kalaieha, Laumaia, Keanakolu and Umikoa on Mauna Kea, Puu Waawaa on Hualalai, west Keawewai, above Kipuka Ahiu on Mauna Loa, and near Hilo. Currently on Maui there are two occurrences with 18 individuals found in Kalialinui within the East Maui Watershed Partnership. On the island of Hawaii, *A. f.* var. *insulare* is currently found in 17 occurrences with more than 600 individuals. There are 13 occurrences in the Pohakuloa Training Area, one in Hawaii Volcanoes National Park, two just south of the Upper Waiakea Forest Reserve and the Mauna Loa Forest Reserve, and one occurrence in the Keokea section of the South Kona District (68 FR 25934; 68 FR 39624).

***Threats and Stressors*****Stressor:****Exposure:****Response:****Consequence:**

**Narrative:** *Asplenium fragile* var. *insulare* is threatened by browsing by feral sheep and goats; competition for light, space and nutrients with *Pennisetum setaceum*; and habitat degradation or destruction when lava tubes or caves fill with debris and subsequent invasion by non-native plants. Fire and military operations also threaten this species, and, due to the small remaining number of occurrences and individuals, a single natural or human-caused environmental disturbance could be catastrophic to the species (U.S. Army 2003a).

***Recovery******Conservation Measures and Best Management Practices:***

- The most important conservation need of *Asplenium fragile* var. *insulare* is to protect high-elevation lava tubes which include construction of fenced exclosures around all known occurrences and/or control or removal of feral ungulates. The areas that are most important for protection include the Pohakuloa Training Area, Keahou and Kulani forests and portions of Kapapala and Kau Forest Reserves. In addition, the following conservation actions are needed: propagation and maintenance of genetic stock ex situ, augmentation of extant occurrences and establishment of new occurrences within the species' historical range; control or eradication of non-native plants, protection from fire and human disturbance; implementation of a comprehensive monitoring program; surveys to identify individuals and/or occurrences that may exist in former habitats, or that may be present in areas that have not been surveyed recently. The establishment of Waihaka Natural Area Reserve and protection of its native habitat are much-needed conservation actions for *A. f.* var. *insulare* (Service 1998a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of *A. fragile* var. *insulare* is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration.

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## **SPECIES ACCOUNT: *Asplenium scolopendrium* var. *americanum*** **(American hart's-tongue fern)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 7/14/1989; Northeast Region (R5) (USFWS, 2016)

### **Physical Description**

A perennial fern with evergreen strap-shaped fronds that are 12 to 42 cm long, 2 to 4.5 cm wide, and auriculate at their base. The green petiole is 3 to 12 cm long and has cinnamon-colored scales. The sori (groups of spore-producing reproductive structures called sporangia) are linear in shape and occur on the underside of the blade portion of the frond. The fronds arise in a cluster from a short, creeping rhizome covered with cinnamon-colored scales (USFWS, 1993).

### **Taxonomy**

Aspleniaceae

### **Historical Range**

See current range/distribution.

### **Current Range**

Known from New York, Michigan, Alabama (two counties in each) and Tennessee (one county); and in the province of Ontario, Canada (USFWS, 1993).

### **Critical Habitat Designated**

No;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: Spores (NatureServe, 2015)

### **Reproduction Narrative**

Adult: This species reproduces only via spores, which apparently require the presence of cool, moist, calcareous environments for development. Bryophytes appear crucial to the survival of sporeling and enhance seedling regeneration by providing a favorable site for fertilization, spore germination and gametophyte growth. New fronds are produced at the start of each growing season, and likewise remain functional for two growing seasons (NatureServe, 2015).

### **Habitat Type**

Adult: Terrestrial (USFWS, 1993)

### **Habitat Vegetation or Surface Water Classification**

Adult: Dolomitic limestone outcrops (northern populations); within limestone pits (southern populations) (USFWS, 1993)

**Environmental Specificity**

Adult: Very narrow to narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: This species is found on dolomitic limestone outcrops (northern populations) or within limestone pits (southern populations), in areas of high humidity, shaded conditions, and a moist substrate (USFWS, 1993). It typically occurs in moist crevices, on mossy rock outcrops, or in sinkholes or blowholes of limestone caves. Most populations are associated with cool, well-shaded, moist microclimates; many occur in shady hardwood woodlands where sun flecks provide sufficient sunlight and where moisture is adequate. Most adult plants were found beneath 0-25% herbaceous cover, while most sporelings were found beneath a higher percentage (26- 50%) of herb cover. Few individuals of any life stage were found where herbaceous cover exceeded 75% (NatureServe, 1993).

***Dispersal/Migration*****Motility/Mobility**

Adult: Abiotic (EPA, 2016)

**Dispersal/Migration Narrative**

Adult: The dispersal pathway is not described, but is thought to be abiotic (EPA, 2016).

***Population Information and Trends*****Population Trends:**

Decline of <50% to relatively stable (NatureServe, 2015)

**Species Trends:**

Decline of <30% to relatively stable (NatureServe, 2015)

**Resiliency:**

Medium (inferred from NatureServe)

**Representation:**

Medium (inferred from NatureServe)

**Redundancy:**

Medium (inferred from NatureServe)

**Number of Populations:**

Approximately 106 extant occurrences rangewide (28 in the United States; 78 in Canada) (NatureServe, 2015)

**Population Size:**

Approximately 5500-6500 individuals in the United states; at least 30,000 individuals in Canada (NatureServe, 2015)

**Population Narrative:**

There are approximately 106 extant occurrences rangewide (28 in the United States; 78 in Canada), with approximately 5500-6500 individuals in the United States, and at least 30,000 individuals in Canada. Population within the sinkholes in Alabama and Tennessee should be considered extremely fragile due to their position on the walls of sinkholes used by spelunkers. Northern populations are likely less fragile. Long-term trend is a decline of 50% to relatively stable, and short-term trend is a decline of <30% to relatively stable (NatureServe, 2015).

**Threats and Stressors**

**Stressor:** Habitat destruction or modification (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** American hart's-tongue fern is threatened throughout most of its range by trampling and habitat alteration or destruction caused by timber removal, quarrying or residential development. Quarrying operations destroyed three of New York's populations and could pose a threat to at least one of the remaining New York sites and two of the southern sites (Clemants in litt., Evans 1981). Timber removal at most of the sites would be expected to raise light levels and lower humidity levels to the detriment of the species. Alterations associated with residential or other development would, in most cases, either directly destroy the plants present or result in environmental changes that would make the sites unsuitable for American hart's-tongue fern. The Michigan sites that are on USFS lands should receive protection from habitat destruction. Timber harvest, quarrying, or other types of development are considered to be the most significant threats to the Ontario populations of the species (USFWS, 2012).

**Stressor:** Invasive plants (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** American hart's-tongue fern is threatened throughout most of its range by competition or shading from invasive plants. The invasive plant swallow-wort (*Vincetoxicum rossicum*) is the most serious threat to some populations of the species in New York and may eventually threaten all populations. Other invasive species affecting New York populations of American Hart's-tongue ferns include exotic honeysuckles (*Lonicera* spp.) and European buckthorn (*Rhamnus cathartica*) (Leopold, pers. comm. 2012). Leopold (unpublished data) noted the presence of invasive species at 8 out of 14 New York sites that were monitored during 2008. The southern populations remain vulnerable to extirpation by inadvertent trampling because of their small size and the steep precarious nature of their habitat (USFWS, 2012).

**Stressor:** Herbivory (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** While reports of herbivory affecting American hart's-tongue fern populations are not common, Marr (2006) observed fronds on some plants with holes or eroded margins. Slugs, snails, molds, and insects were suggested as possible causes; though, none were directly observed damaging frond tissues (USFWS, 2012).

**Stressor:** Inadequacy of existing regulatory mechanisms (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** American hart's-tongue fern is listed as endangered under Michigan's Endangered Species Protection Law (Act 451 of 1994, Part 365) and Tennessee's Rare Plant Protection and Conservation Act. In Michigan, taking is prohibited on all public and private lands. In Tennessee, taking is only restricted when the permission of the landowner or manager has not been obtained. In New York the species is protected under the Protected Native Plants Law that prohibits collection on State lands and states that removal of the fern from private lands without the landowner's permission is a violation of the law and subjects the violator to a \$25 fine. Alabama does not directly protect endangered and threatened plants. However, American hart's-tongue fern is protected as a form of cave life by the Alabama Cave Conservation Act of 1988. The species' current status on the Federal List of Endangered and Threatened Plants provides additional protection from taking on Federal lands. Protection from inappropriate commercial trade (utilizing plants of wild origin rather than cultivated material) is also provided (USFWS, 2012).

**Stressor:** Other natural or manmade factors affecting its continued existence (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The loss of shade that resulted from this alteration of the canopy desiccated many of the ferns growing on the forest floor. Insect infestations that temporarily remove the leaves of the canopy or result in long-term damage or death to the trees found there remain a threat to the species. Mats of bryophytes were sometimes seen to slough off of boulders where American hart's-tongue ferns were found in Michigan, and in at least one case a mature fern was dislodged along with the moss mat in which it was positioned. While the cause or extent of bryophytes sloughing off boulders is not known, the loss of this substrate type could reduce availability of suitable sites for gametophyte development if it occurred throughout sites harboring occurrences of American hart's-tongue fern (USFWS, 2012).

## ***Recovery***

### **Reclassification Criteria:**

Not available.

### **Delisting Criteria:**

1. It has been documented that at least 15 U.S. occurrences (2 in Alabama, 2 in Tennessee, 4 in Michigan, and 7 in New York) are self-sustaining and occur on sufficiently large tracts to ensure their perpetuation with a minimal amount of active management (USFWS, 1993).
2. All of the populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 1993).

### **Recovery Actions:**

- Protect existing populations and essential habitat (USFWS, 1993).
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor (USFWS, 1993).
- Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1993).
- Enforce laws protection the species and/or its habitat (USFWS, 1993).
- Develop materials to inform the public about the status of the species and the recovery plan objectives (USFWS, 1993).
- Annually assess the success of recovery efforts for the species (USFWS, 1993).

***Conservation Measures and Best Management Practices:***

- Develop and implement a program to control swallow-wort at sites harboring American hart's-tongue populations in New York and to provide for early detection and removal from sites in Michigan. This task is urgent given the prevalence of this threat to populations in New York and the rapid expansion of swallow-wort that has been seen in sites where American hart's-tongue fern occurs.
- Fund and coordinate range-wide surveys of all populations at two to five-year intervals (USFWS, 2012).
- Conduct long-term monitoring of microenvironmental characteristics of sites in Tennessee and Alabama to document ranges of variability in factors such as humidity, soil moisture, solar insolation, abundance of bryophytes and herbaceous vascular plants, and canopy cover. These data will be necessary to evaluate whether regional changes in climate patterns affect site suitability at the localized scale (USFWS, 2012).
- Provide protection for the remaining occupied sites in Tennessee and Alabama (USFWS, 2012).
- Conduct detailed genetic studies of the species throughout North America to assess population genetic structure and to guide potential reintroduction/augmentation projects in Tennessee and Alabama (USFWS, 2012).
- Continue developing propagation techniques for the southern populations of American hart's-tongue and evaluate potential for augmenting or reestablishing populations at these sites using sporophyte material produced from collections made at southern sites (USFWS, 2012).
- Develop and implement a program to ensure that damage to or destruction of overstory trees by insect pests at occupied sites does not permanently alter site microclimate to the extent that the sites are no longer suitable for American Hart's-tongue fern (USFWS, 2012).

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## SPECIES ACCOUNT: *Asplenium unisorum* (= *Diellia unisora*) (Single-sorus island-spleenwort)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 06/27/1994; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

A fern with a short stem. Stalks of the fronds are black and shiny. Fronds are very narrow, once-divided, and 8 - 30 cm long (NatureServe, 2015).

### **Taxonomy**

*Diellia* is a genus endemic to Hawaii and includes six species, all of which may have originated from a single common ancestor (Palmer 2003). *Diellia unisora* hybridizes with *D. falcata* to form an endemic hybrid *Diellia lauui*. The species is now considered *Asplenium unisora* (Schneider et al. 2005) (USFWS, 2011).

### **Historical Range**

Historically, *Diellia unisora* was known from steep, grassy, rocky slopes on the western side of the Waianae Mountains, Oahu (USFWS 1995, Wagner 1952) (USFWS, 1998).

### **Current Range**

This species is known to be extant in four areas of the southern Waianae Mountains: South Ekahanui Gulch, Palawai Gulch, Palikea, and the Pualii-Napepeiauolelo Ridge (HHP 1997; J. Lau, pers. comm. 1997) (Oahu) (USFWS, 1998).

### **Critical Habitat Designated**

Yes; 6/17/2003.

### **Legal Description**

On September 18, 2012, the U.S. Fish and Wildlife Service designated critical habitat for *Diellia unisora*.

### **Critical Habitat Designation**

Oahu—Lowland Mesic—Unit 1, Oahu—Lowland Mesic—Unit 2, Oahu— Lowland Mesic—Unit 3, Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff— Unit 8 constitute critical habitat for *Diellia unisora* on Oahu.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). This unit is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. grimesiana* ssp. *obatae*, *C. longiflora*, *C. superba*, *Cyrtandra dentata*, *Delissea*

subcordata, *Diellia falcata*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Hesperomannia arborescens*, *H. arbuscula*, *Hibiscus brackenridgei*, *Isodendron laurifolium*, *I. longifolium*, *Kadua degeneri*, *Lobelia niahauensis*, *Melanthra tenuifolia*, *Melicope makahae*, *M. pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia kaalaensis*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea hookeri*, *S. kaalae*, *S. nuttallii*, *S. obovata*, and *Viola chamissoniana* ssp. *chamissoniana*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Mesic—Unit 1 is not known to be occupied by the plants *Chamaesyce celastroides* var. *kaenana*, *Cyanea pinnatifida*, *Cyperus pennatifolius*, *Diellia unisora*, *Diplazium molokaiense*, *Eugenia koolauensis*, *Gardenia mannii*, *Gouania meyenii*, *G. vitifolia*, *Kadua coriacea*, *K. parvula*, *Labordia cyrtandrae*, *Melicope saint-johnii*, *Phyllostegia hirsuta*, *P. mollis*, *P. parviflora*, *Plantago princeps*, *Sanicula maritima*, *Silene perlmutteri*, *Solanum sandwicense*, *Stenogyne kanaloana*, *Tetramolopium lepidotum* ssp. *lepidotum*, or *Urera kaalae*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

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

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

Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit is occupied by the plants *Alectryon macrococcus*, *Cenchrus agrimonoides*, *Delissea subcordata*, *Diellia falcata*, *D. unisora*, *Hesperomannia arbuscula*, *Melicope saint-johnii*, *Phyllostegia mollis*, *P. parviflora*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Schiedea kaalae*, *Silene perlmannii*, and *Urera kaalae*, and includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

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

Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Dry Cliff—Unit 2 is occupied by the plants *Abutilon sandwicense*, *Alectryon macrococcus*, *Dubautia herbstobatae*, *Gouania vitifolia*, *Kadua parvula*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *Nototrichium humile*, *Peucedanum sandwicense*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Sanicula*

mariversa, *Schiedea hookeri*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 2 is not currently occupied by *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *C. kuwaleana*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *Isodendron laurifolium*, *I. pyriforme*, *Kadua degeneri*, *Korthalsella degeneri*, *Lipochaeta lobata* var. *leptophylla*, *Melicope saint-johnii*, *Neraudia angulata*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Schiedea obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmanii*, *Spermolepis hawaiiensis*, or *Tetramolopium lepidotum* ssp. *lepidotum*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

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

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. This unit is occupied by the plants *Alectryon macrococcus*, *Chamaesyce kuwaleana*, and *Spermolepis hawaiiensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing

the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 4 is not currently occupied by *Abutilon sandwicense*, *Achyranthes splendens* var. *rotundata*, *Bonamia menziesii*, *Cenchrus agrimonioides*, *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyrtandra dentata*, *Diellia falcata*, *D. unisora*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Flueggea neowawraea*, *Gouania meyenii*, *G. vitifolia*, *Isodendron laurifolium*, *I. pyriformis*, *Kadua degeneri*, *K. parvula*, *Korthalsella degeneri*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophylla*, *Lobelia niihauensis*, *Melanthera tenuifolia*, *Melicope makahae*, *M. saintjohnii*, *Neraudia angulata*, *Nototrichium humile*, *Peucedanum sandwicense*, *Phyllostegia kaalaensis*, *Plantago princeps*, *Platydesma cornuta* var. *decurrens*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, *Sanicula mariversa*, *Schiedea hookeri*, *S. obovata*, *S. trinervis*, *Silene lanceolata*, *S. perlmannii*, *Tetramolopium filiforme*, *T. lepidotum* ssp. *lepidotum*, or *Viola chamissoniana* ssp. *chamissoniana*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. The unit is occupied by the plants *Cenchrus agrimonioides*, *Diellia unisora*, *Flueggea neowawraea*, *Lepidium arbuscula*, *Lobelia niihauensis*, *Melicope saintjohnii*, *Neraudia angulata*, *Plantago princeps*, *Pleomele forbesii*, *Pteralyxia macrocarpa*, and *Tetramolopium lepidotum* ssp. *lepidotum*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

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

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

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

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

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

**Primary Constituent Elements/Physical or Biological Features**

- (i) In units Oahu—Lowland Mesic— Unit 1, Oahu—Lowland Mesic—Unit 2, and Oahu—Lowland Mesic—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.
- (ii) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

**Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas.

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Metrosideros polymorpha (ohia) mixed mesic and wet forest cliffs, Metrosideros polymorpha-Acacia koa (koa) lowland mesic relic forest, Metrosideros polymorpha-Dicranopteris linearis (uluhe)-Schinus terabinthifolius forest (USFWS, 2011)

**Dependencies on Specific Environmental Elements**

Adult: Deep shade, open understory (USFWS, 1998)

**Geographic or Habitat Restraints or Barriers**

Adult: 1,750 - 2,500 ft. elevation (USFWS, 1998)

**Habitat Narrative**

Adult: Inhabits moist grasslands, shrublands and forests. On rocky gulch slopes. At some sites, the native vegetation has been largely displaced by alien vegetation (NatureServe, 2015). In Palikea and the slopes below, the habitat of *Asplenium unisora* is *Metrosideros polymorpha* (ohia) mixed mesic and wet forest cliffs. At Honouliuli, the habitat where *Asplenium unisora* occurs is *Metrosideros polymorpha*-*Acacia koa* (koa) lowland mesic relic forest. At Pualii Gulch, *Asplenium unisora* was observed growing in *Metrosideros polymorpha*-*Dicranopteris linearis* (uluhe)-*Schinus terabinthifolius* forest (USFWS, 2011). It typically grows in deep shade or open understory in dryland forest at an elevation of 530 to 760 meters (1,750 to 2,500 feet) (USFWS 1995; 1998).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Resiliency:**

Very low (inferred from NatureServe, 2015)

**Redundancy:**

Very low (inferred from USFWS, 2011)

**Number of Populations:**

2 (USFWS, 2011)

**Population Size:**

1,148 (USFWS, 2011)

**Population Narrative:**

It is endemic to a 4 km long stretch of the southern Waianae Mountains (NatureServe, 2015). Since 2003, 1,148 individuals have been observed in two populations (USFWS, 2011).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** In the Waianae Mountains where *Asplenium unisora* is found, feral pigs (*Sus scrofa*) and goats (*Capra hircus*) disturb the ground and significantly contribute to erosion, and together represent the single greatest threat to this species. Invasive introduced plants also degrade the

habitat and invade openings created by disturbance, thus crowding out areas which might otherwise recruit and support new sporelings (Agurauja 2005) (USFWS, 2011). Alien plants include *Schinus terebinthifolius* (Christmas berry), *Melinis minutiflora*, *Passiflora suberosa*, and *Psidium cattleianum* (Strawberry guava) (NatureServe, 2015).

**Stressor:** Predation (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Rats (*Rattus rattus*) and goats are believed to eat *Asplenium unisora* (Perlman 2009) (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2011).

### **Recovery**

#### **Reclassification Criteria:**

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

#### **Delisting Criteria:**

1. A total of 8 to 10 populations of the species should be documented on Oahu and at least one other island where it now occurs or occurred historically (USFWS, 1998).
2. Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).
3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

#### **Recovery Actions:**

- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).

- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct enclosures to protect populations against feral pigs (USFWS, 1998).
- Control competing alien plant species within enclosures (USFWS, 1998).
- Maintain adequate genetic stock (USFWS, 1998).
- Conduct research into additional limiting factors (USFWS, 1998).
- Conduct genetic/taxonomic research (USFWS, 1998).

***Conservation Measures and Best Management Practices:***

- Collect material for genetic storage and propagation for reintroduction (USFWS, 2011).
- Fence all populations to provide protection against the negative impacts of feral ungulates (USFWS, 2011).
- Mitigate current erosion conditions in the vicinity of known populations (USFWS, 2011).
- Control invasive introduced plant species around all populations (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).

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## SPECIES ACCOUNT: *Ctenitis squamigera* (Pauoa)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 09/26/1994; Pacific Region (R1) (USFWS, 2016)

#### **Physical Description**

A fern with a creeping rhizome. Leaf stalks are 20 - 60 cm long and covered with tan-colored scales. Dark-green fronds are covered with tan-colored scales (NatureServe, 2015).

#### **Taxonomy**

A member of the woodfern family (Aspleniaceae) (USFWS, 2016).

#### **Historical Range**

Historically, *Ctenitis squamigera* was recorded from Kauai, the Koolau and Waianae Mountains of Oahu, Lanai, Molokai, Maui, and the island of Hawaii (USFWS, 2016).

#### **Current Range**

This species is currently extant on Oahu, Molokai, Lanai, and Maui (USFWS, 2016).

#### **Critical Habitat Designated**

Yes; 2/27/2003.

#### **Legal Description**

On March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Ctenitis squamigera*.

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Ctenitis squamigera* (Pauoa) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Ctenitis squamigera* (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Ctenitis squamigera* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Ctenitis squamigera* on the island of Kauai (68 FR 9116 - 9479).

#### **Critical Habitat Designation**

Maui—Lowland Dry—Unit 1, Maui— Lowland Dry—Unit 2, Maui—Lowland Dry—Unit 3, Maui—Lowland Dry—Unit 4, Maui—Lowland Dry—Unit 5, Maui— Lowland Dry—Unit 6, Maui—Lowland Mesic—Unit 1, Maui—Lowland Mesic— Unit 2, Maui—Lowland Mesic—Unit 3, Maui—Lowland Wet—Unit 2, Maui— Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, Maui— Lowland Wet—Unit 8, Maui—Montane Mesic—Unit 2, Maui—Montane Mesic— Unit 3, Maui—Montane Mesic—Unit 4, Maui—Montane Mesic—Unit 5, Maui— Wet Cliff—Unit 6, Maui—Wet Cliff— Unit 7, and Maui—

Wet Cliff—Unit 8 constitute critical habitat for *Ctenitis squamigera* on Maui. Molokai—Lowland Mesic—Unit 1 constitutes critical habitat for *Ctenitis squamigera* on Molokai.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants *Bonamia menziesii*, *Cenchrus agrimonoides*, *Flueggea neowawraea*, *Melicope adscendens*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by *Alectryon macrococcus*, *Bidens micrantha* ssp. *kalealaha*, *Canavalia pubescens*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Sesbania tomentosa*, *Solanum incompletum*, or *Zanthoxylum hawaiiense*, the Service has determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant *Canavalia pubescens*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*,

*Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, the Service has determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem. Although Maui—Lowland Dry—Unit 4 is not currently occupied by *Bidens micrantha* ssp. *kalealaha*, *Bonamia menziesii*, *Canavalia pubescens*, *Cenchrus agrimonoides*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Flueggea neowawraea*, *Hibiscus brackenridgei*, *Melanthera kamolensis*, *Melicope mucronulata*, *Neraudia sericea*, *Nototrichium humile*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Solanum incompletum*, *Spermolepis hawaiiensis*, or *Zanthoxylum hawaiiense*, the Service has determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonoides*, *Gouania hillebrandii*, *Kadua coriacea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Spermolepis hawaiiensis*, and *Tetramolopium capillare*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by *Ctenitis squamigera*, *Cyanea obtusa*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei*, *Lysimachia lydgatei*, *Neraudia sericea*, *Schiedea salicaria*, *Sesbania tomentosa*, or *T. remyi*, the service has determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants *Hibiscus brackenridgei* and *Schiedea salicaria*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—

Lowland Dry—Unit 6 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Cenchrus agrimonioides*, *Ctenitis squamigera*, *Cyanea obtusa*, *Gouania hillebrandii*, *Hesperomannia arbuscula*, *Kadua coriacea*, *Lysimachia lydgatei*, *Neraudia sericea*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Sesbania tomentosa*, *Spermolepis hawaiiensis*, *Tetramolopium capillare*, or *T. remyi*, the Service has determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 1 consists of 1,147 ac (464 ha) of State land, 241 ac (97 ha) of privately owned land, and 494 ac (200 ha) of federally owned land (Haleakala National Park), from Manawainui Valley to Kukuila on the eastern slopes of east Maui. This unit is occupied by the plants *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, and *Huperzia mannii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 1 is not known to be occupied by *Ctenitis squamigera* or *Solanum incompletum*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, and *Zanthoxylum hawaiiense*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, or *Colubrina oppositifolia*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens campylotheca* ssp. *pentamera*, *Colubrina oppositifolia*, *Ctenitis squamigera*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Zanthoxylum hawaiiense*, or by the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the

conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the

expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

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

habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

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

Maui—Montane Mesic—Unit 2 consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Montane Mesic—Unit 3 consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland

and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Wet Cliff—Unit 7 consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendron pyriformis*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Molokai—Lowland Mesic—Unit 1 consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants *Alectryon macrococcus*, *Ctenitis squamigera*, *Cyanea dunbariae*, *C. mannii*, *C. profuga*, *Cyperus fauriei*, *Cyrtandra filipes*, *Gouania hillebrandii*, *Labordia triflora*, *Neraudia sericea*, *Santalum haleakalae* var. *lanaiense*, *Schiedea lydgatei*, *S. sarmentosa*, *Silene alexandri*, *S. lanceolata*, *Spermolepis hawaiiensis*, and *Zanthoxylum hawaiiense*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory

native plant species identified as physical or biological features in the lowland mesic ecosys. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

The critical habitat designation for *Ctenitis squamigera* includes 7 critical habitat units, covering one ecosystem type, which encompasses approximately 7,823 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

The critical habitat designation for *Ctenitis squamigera* includes one unit totaling 1,817 acres in Kauai County, Hawaii. The unit is Kauai 11—*Ctenitis squamigera*—a.

Kauai 11—*Ctenitis squamigera*—a: This unit is critical habitat for *Ctenitis squamigera* and is 735 ha (1,817 ac) on State land (Kuia NAR). This unit contains Mahanaloa Valley and Milolii Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Ctenitis squamigera* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, rock faces in gulches in the understory of *Metrosideros polymorpha*-*Diospyros* spp. mesic forest and diverse mesic forest. It provides habitat for the westernmost range of the species and the rock face habitat requirement that is unique to Kauai. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

**Primary Constituent Elements/Physical or Biological Features**

(i) In units Maui—Lowland Dry—Unit 1, Maui—Lowland Dry—Unit 2, Maui—Lowland Dry—Unit 3, Maui—Lowland Dry—Unit 4, Maui—Lowland Dry—Unit 5, and Maui—Lowland Dry—Unit 6, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Less than 50 in (130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

(ii) In units Maui—Lowland Mesic—Unit 1, Maui—Lowland Mesic—Unit 2, and Maui—Lowland Mesic—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

(iii) In units Maui—Lowland Wet—Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, and Maui—Lowland Wet—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

(iv) In units Maui—Montane Mesic—Unit 2, Maui—Montane Mesic—Unit 3, Maui—Montane Mesic—Unit 4, and Maui—Montane Mesic—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

(v) In units Maui—Wet Cliff—Unit 6, Maui—Wet Cliff—Unit 7, and Maui—Wet Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, ferns, Coprosma, Dubautia, Kadua, Peperomia.

In unit Molokai—Lowland Mesic—Unit 1, the physical and biological features of critical habitat are:

(i) Elevation: Less than 3,300 ft (1,000 m).

(ii) Annual precipitation: 50 to 75 in (130 to 190 cm).

(iii) Substrate: Shallow soils, little to no herbaceous layer.

(iv) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum.

(v) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax.

(vi) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Ctenitis squamigera* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Ctenitis squamigera* occurs within the indicated ecosystem in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

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

(i) Rock faces in gulches in the understory of *Metrosideros polymorpha*/*Diospyros* spp. mesic forest and diverse mesic forest and containing one or more of the following native plant species: *Myrsine* spp., *Psychotria* spp., or *Xylosma* spp.; and

(ii) Elevations between 538 and 1,069 m (1,765 and 3,507 ft).

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of this species will continue to be degraded and destroyed.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Ctenitis squamigera* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats

will require the implementation of special management actions within each of the critical habitat areas identified for this species.

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

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access

### ***Life History***

### **Food/Nutrient Resources**

### **Reproduction Narrative**

Adult: Not available

### **Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

### **Habitat Vegetation or Surface Water Classification**

Adult: Moist M. polymorpha or diverse forest (NatureServe, 2015; USFWS, 2016)

### **Geographic or Habitat Restraints or Barriers**

Adult: 1,269 - 3,027 ft. elevation (USFWS, 2016)

### **Habitat Narrative**

Adult: Inhabits moist forests on gulch slopes and in gulch bottoms (NatureServe, 2015). *Ctenitis squamigera* is found on gentle to steep slopes in *Metrosideros polymorpha*-*Diospyros sandwicensis* mesic forest and diverse mesic forest at elevations of 387 to 923 m (1,269 to 3,027 ft) (USFWS, 2016).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Declining (USFWS, 2013)

**Resiliency:**

Low to moderate (inferred from USFWS, 2016; see current range/distribution)

**Number of Populations:**

17 (USFWS, 2016)

**Population Size:**

210 - 220 (USFWS, 2013)

**Population Narrative:**

As of 2005, there were 17 population units state-wide, totaling approximately 350 individuals (USFWS, 2016). Overall, the numbers of individuals have declined from approximately 230-240 reported in the previous five-year review, to approximately 210-220 in 2013, although many populations have not been thoroughly surveyed in the intervening years (USFWS, 2013).

***Threats and Stressors***

**Stressor:** Habitat degradation (NatureServe, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Threats include alien plants, ungulates, and landslides (NatureServe, 2015). Habitat degradation caused by axis deer is now considered a major threat to the forests of Lanai and all three of the Lanai populations/occurrences of *C. squamigera* are negatively affected to some extent by axis deer (Service 1999b) (USFWS, 2016).

**Stressor:** Recreation (USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Human disturbance from hikers, vehicles, etc. is believed to pose a significant threat to this species (USFWS, 2016).

**Stressor:** Stochastic events (USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** With only three populations harboring more than 50 mature, reproducing individuals, located on two islands, this species has a high risk of background extinction (USFWS, 2016).

**Stressor:** Climate change (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

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

**Stressor:** Invasive plants (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** In Ukumehame on West Maui, the population is threatened by competition from the introduced invasive plant species *Erigeron karvinskianus* (daisy fleabane) (H. Oppenheimer, pers. comm. 2011) (USFWS, 2013).

## ***Recovery***

### **Reclassification Criteria:**

1. A total of five to seven populations should be documented on islands where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with a minimum of 300 mature individuals per population (USFWS, 1998).
3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1998).

### **Delisting Criteria:**

1. A total of 8 to 10 populations should be documented on islands where they now occur or occurred historically (USFWS, 1998).
2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with a minimum of 300 mature individuals per population (USFWS, 1998).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1998).

### **Recovery Actions:**

- Protect habitat and control threats (USFWS, 1998).
- Expand current populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).

- Reestablish wild populations within the historic range (USFWS, 1998).
- Validate and revise recovery objectives (USFWS, 1998).
- On Lanai, building exclosures around some of the most intact portions of native forest in conjunction with hunting would provide good protection for endangered species, including *Ctenitis squamigera* (R. Hobdy, personal communication 1995) (USFWS, 1998).
- Oahu populations of *Ctenitis squamigera* would benefit from the proposed expansion of the Mt. Kaala NAR to include Waianae-Kai Forest Reserve and Makaleha Valley Forest Reserve (Talbert Takahama, DOFAW, personal communication 1995). Please refer to the Stepdown Narrative section on page 47 of this plan for the overall recovery strategy (USFWS, 1998).

***Conservation Measures and Best Management Practices:***

- About five individuals (one percent of all remaining individuals) of this species occur in two Makua management units where they will benefit from population unit and/or ecosystem-level protection. The management units include West Makaleha and Ohikilolo which are fenced (USFWS, 2016).
- The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any *C. squamigera* within the preserve (USFWS, 2016).
- Captive propagation for genetic storage and reintroduction: Continue collection of genetic resources for storage, future propagation and reintroduction into protected suitable habitat within historical range. Augment current natural populations to increase number of individuals. Investigate methods of propagation and storage of spores (USFWS, 2013).
- Ungulate exclosures - Complete exclosure fences to protect individuals from the adverse effects of feral pigs and goats (USFWS, 2013).
- Ecosystem-altering invasive plant species control - Eradicate introduced invasive plant species within ungulate exclosures and maintain the exclosures free of introduced invasive plants (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).
- Surveys / Inventories - Survey geographical and historical range for a thorough current assessment of the species' status (USFWS, 2013).
- Genetic research - Assess genetic variability within extant populations (USFWS, 2013).
- Population biology research - Study *Ctenitis squamigera* populations with regard to population size and structure, geographical distribution, spore production and gametophytic stage development, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).

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## **SPECIES ACCOUNT: *Cyathea dryopteroides* (Elfin tree fern)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 6/16/1987; Southeast Region (Region 4) (USFWS, 2015)

#### **Physical Description**

A small or dwarf tree fern reaching 24 inches (60 centimeters) in height and approximately 1 inch (2 to 3 centimeters) in diameter. The fronds are bipinnate, nearly hairless, tape at both ends, and reach 36 inches (90 centimeters) in length and 10 inches (25 centimeters) in width. The sori are located dorsally and are enclosed in a cup-shaped indusium. (USFWS, 1990)

#### **Taxonomy**

Not Available

#### **Historical Range**

Based on historical records of the elfin tree fern, the species seem to be associated to small remnants of dwarf forest vegetation at the highest elevation points of Puerto Rico, particularly to shady forest of sierra palm (*Prestoea acuminata*) with a relatively open understory (Omar Monseguir, USFWS, pers. comm., 2012). (USFWS, 2013)

#### **Current Range**

Only three populations are known for the elfin tree fern. It is found on three peaks located approximately 12 miles (20 kilometers) apart, Monte Guilarte, Cerro Rosa and Monte Jayuya. A total of approximately 95 individuals have been located at these three sites. (USFWS, 1990)

#### **Critical Habitat Designated**

Yes;

#### ***Life History***

#### **Food/Nutrient Resources**

#### **Reproduction Narrative**

Adult: Not available

#### **Habitat Type**

Adult: Terrestrial (EPA, 2016)

#### **Habitat Vegetation or Surface Water Classification**

Adult: Subtropical lower montane wet forest (EPA, 2016)

#### **Geographic or Habitat Restraints or Barriers**

Adult: Occurs at elevations between 3,900 - 4,260 ft. (EPA, 2016)

#### **Dependency on Other Individuals or Species for Habitat**

Adult: Sierra palm (EPA, 2016)

**Habitat Narrative**

Adult: Dwarf forests and elfin forests in central mountains of Puerto Rico. Evergreen montane forest seldom exceeding 7 meters in height. Elfin forest usually found on rounded mountaintops. Commonwealth forests of Toro Negro and Monte Guilarte. Described as subtropical lower montane wet forest and subtropical wet forest life zones. Species is usually a component of the groundcover within almost pure stands of sierra palm. The evergreen forest is characterized by a single canopy layer (~22 ft.), dense thickets, and mosses, liverworts, and bromeliads. Elevations at known sites range from 3900 to 4260 ft. (EPA, 2016). The species characteristic of being associated with remnants of dwarf forest vegetation may indicate that it is associated to late successional vegetation (USFWS, 2013).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Unknown (USFWS, 2013)

**Species Trends:**

Uncertain (USFWS, 2013)

**Number of Populations:**

4 (USFWS, 2013)

**Population Narrative:**

The species status is uncertain; the status and distribution of the elfin tree fern has not been re-evaluated since 1981 (Proctor 1989). The elfin tree fern is known from four populations. Overall, the populations of the elfin tree fern have been poorly monitored and no information on population trends and demographic features are currently available (USFWS, 2013).

***Threats and Stressors***

**Stressor:** Development (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Although the known populations are located within Commonwealth Forests, these areas may be subjected to development for expansion of telecommunication infrastructure. Both the final listing rule (52 FR 22936) and the species' recovery plan (USFWS 1991) indicate that the construction of new communication facilities or expansion of existing ones would affect the elfin tree fern. In Puerto Rico, towers for cellular communication, radio, television, military and governmental purposes have long represented a threat to those plant species that happen to occur on mountaintops. Their proliferation has increased with the advent of cellular phone and related technologies. While the towers themselves may not occupy a very large area, associated construction activities, access roads and facilities have a much wider impact, resulting in the

elimination of potential habitat for the species. Additionally, construction of new access road and trails were identified as a factor that could directly (i.e., destruction of individuals) or indirectly (i.e., slope instability) reduce the number of elfin tree fern and its habitat at Monte Jayuya (Omar Monsegur, USFWS, pers. comm., 2012).

**Stressor:** Vegetation management and road maintenance (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Currently, vegetation management around the existing telecommunication towers and associated facilities, and along the existing power lines that service these facilities may be a threat to the fern and its habitat (Monsegur and Saliva, USFWS, unpubl. data, 2012). Mr. José R. Román (former manager of the Toro Negro Commonwealth Forest, pers. comm., 2012), states that the telecommunication companies and the Puerto Rico Energy and Power Authority (PREPA) conduct maintenance activities such as trimming and clearing the vegetation without coordination with the forest manager, affecting the forest vegetation, including the elfin tree fern habitat. Road maintenance activities were also identified as being a factor that could directly or indirectly reduce the number of plants near roads (USFWS 1991). Since the population dynamics of the species is poorly known, we understand that the impacts discussed above could be detrimental to the species as a whole. Clearing of vegetation may result in direct (i.e., cutting of individuals) or indirect impacts (i.e., by opening forest gaps that can serve as corridors for invasives) to the species (USFWS, 2013).

**Stressor:** Small population size and limited distribution (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The most important factors affecting the continued existence of the elfin tree fern are its limited distribution, low reproductive capacity and highly specialized ecological requirements. In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes, landslides, human induced fires and reduced genetic variation. The elfin tree fern is more susceptible to natural disturbances such as hurricanes or landslides, because it is confined to geographically small areas (USFWS 1991) (USFWS, 2013).

**Stressor:** Invasive species (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Invasive native plants such as the fern *Gleichenella pectinata* may invade and alter diverse native dwarf forest communities, often resulting in plant monocultures that support few wildlife species (Omar Monsegur, USFWS, pers. obs., 2012). *Gleichenella pectinata* colonize disturbed areas faster than other native plants, thereby excluding native plants. *Gleichenella pectinata* may grow as an invasive by forming dense mats. Although the mats formed by this species serve as fuel for human induce fires, it seems to be fire tolerant (Omar Monsegur, USFWS, pers. obs., 2012). This invasive fern is currently found occupying areas disturbed by fire, landslides and road construction. If *G. pectinata* continues to spread and colonizes the elfin tree fern habitat, it could alter fire regimes, microclimate and nutrient cycling of the habitat that elfin

tree ferns depend on. Furthermore, the native vine-like fern *Hypolepis repens* was observed in the area colonizing forest gaps probably created by previous hurricanes and growing over the elfin tree fern in Monte Jayuya (Monsegur and Saliva, FWS, unpubl. data, 2012) (USFWS, 2013).

**Stressor:** Fire (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Human induced fire is a current threat for the species at Cerro Guilarte and Monte Jayuya. Areas potentially used by the species in Cerro Guilarte and Monte Jayuya have been affected by human induced fires (Omar Monsegur, USFWS, 2012, pers. obs.). The invasive species found in the area are fire-tolerant and make these sites susceptible to human-induced catastrophic fires. Since fires are not natural to this particular habitat, the native flora is not adapted to such disturbance. Fire effects could accelerate the colonization of invasive plants such as *Gleichenella pectinata* and change the vegetation composition of Monte Jayuya (see discussion under Factor A). The fern *Gleichenella pectinata* seems to be fire tolerant and form mats of dry material that serve as fuel for human induced fires. Although this invasive fern is located in the moist forest, during the dry season human-induced fires have been documented by the Service (Omar Monsegur, USFWS, 2012, pers. obs.) (USFWS, 2013).

**Stressor:** Stochastic events (USFWS, 2013)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Hurricanes or tropical cyclones frequently affect the islands of the Caribbean. Hurricanes contribute to shaping vegetation and ecosystem processes, being it a factor in determining the structure and composition of biotic communities in the Caribbean forest (Walker et al. 1991, Lugo 2000). Hurricane winds often lead to tree defoliation, loss of small and large branches, and up-rooted trees, resulting in damage to adjacent trees and understory plants when trees or branches fall and direct light damage to leaves of understory juveniles exposed to high light levels and temperature (Brokaw and Walker 1991). Additionally, high rainfall associated with tropical storms and hurricanes, sometimes about 24 inches (2 feet) of rain in a single storm event, can cause floods and interacts with topography and geologic substrate to induce mass wasting events, e.g. landslides (Lugo 2000). Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. An expected effect of climate change is the increase in the intensity of hurricanes and storms, followed by extended periods of drought (IPCC 2012). Climate change may alter (modify) the surrounding vegetation around the populations of the elfin tree fern (USFWS, 2013)

**Stressor:** Inadequacy of existing regulatory mechanisms

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Factor D (inadequacy of existing regulatory mechanisms) is now considered a threat for the elfin tree fern (USFWS 2013a), but not for Cook's holly (USFWS 2013b).

## **Recovery**

**Reclassification Criteria:**

At least two new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forests (Monte Guilarte or Toro Negro) or on Federal land within the Caribbean National Forest (now El Yunque National Forest) (USFWS, 2013).

**Delisting Criteria:**

The amended delisting criteria for the elfin tree fern and Cook's holly are as follows: 1. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factors A, B, D and E). 2. The existing six (6) populations of elfin tree fern and the two (2) populations of Cook's holly within protected areas (Commonwealth Forests) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). 3. Establish two (2) additional populations of each the elfin tree fern and the Cook's holly within protected areas that shows a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E) (USFWS, 2017).

**Recovery Actions:**

- Monitor existing populations (USFWS, 1990).
- Protect current habitat (USFWS, 1990).
- Conduct research on the life history of these species, evaluate methods of propagation and to look for reintroduction sites (USFWS, 1990).
- Propagate and produce seedlings for enhancement of existing populations and the establishment of new populations (USFWS, 1990).
- Develop a long-term management and monitoring protocol of natural and established populations to reduce site-specific threats for elfin tree fern and Cook's holly and its habitat. These recovery actions should be coordinated with PRDNER and be included within Task 121; Monitor all known populations of the approved recovery plan (USFWS, 2019).

***Conservation Measures and Best Management Practices:***

- Evaluate the abundance and distribution of the elfin tree fern through surveys within traditional and non-traditional sites, using habitat models and best available plant survey methodology to determine current population numbers (USFWS, 2013).
- Identify the number of viable populations necessary to protect and stabilize the elfin tree fern population (wild, naturally-reproducing populations large enough to maintain sufficient genetic variation, and evolve and respond to natural habitat changes) (USFWS, 2013).
- Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects to this fern from construction, improvement of communication facilities, and construction/expansion of roads and trails in Toro Negro and Guilarte Commonwealth forests (USFWS, 2013).
- As new information is gained on the species, delisting criteria should be developed (USFWS, 2013).
- Studies should be conducted on the species' phenology and its habitat requirements (USFWS, 2013).
- Propagation techniques should be evaluated and developed for the species as new information is gained in order to establish new self sustainable populations in protected areas (USFWS, 2013).

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## SPECIES ACCOUNT: *Cyclosorus boydiae* (Boyd's maiden fern)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

*Cyclosorus boydiae* is a small to medium-sized fern with reclining or erect stems and a large, tangled mass of roots that form a holdfast. Fronds are stiffly upright, once-divided, usually 4 to 12 inches (in) (10 to 30 centimeters (cm)) long. Pinnae are lanceolate, 0.8 to 1.4 in (2 to 3.5 cm) long with obtuse tips (Palmer 2003, pp. 87-88).

### **Taxonomy**

Phylum Filicinophyta; Class Filicopsida; Order Filicales; Family Thelypteridaceae; Genus *Cyclosorus*. *Cyclosorus boydiae* was originally described by Eaton (1879, pp. 361-362). Iwatsuki later moved the species to the genus *Thelypteris* (Iwatsuki 1964, entire; Palmer 2003, pp. 87-88). In 1999, Warren H. Wagner moved the species to *Cyclosorus* and recognized two varieties: var. *kipahuluensis* and var. *boydiae* (Wagner et al. 1999a, entire). In his 2003 review of all Hawaiian ferns, Palmer returned the species to *Christella* and did not recognize any varieties (2003, pp. 87-88). Following Smith et al. 2006, *Christella* was merged into *Cyclosorus* (Snow et al. 2011, entire). This is the most recently accepted name for this taxon (USFWS, 2014; USFWS, 2016).

### **Historical Range**

U.S., Hawaii: Island of Oahu, Honolulu County; Island of Hawaii, County of Hawaii; Island of Maui, Maui County. Historically, this fern was known from near sea level to 4,400 ft (1,350 m) on Oahu, Maui, and Hawaii Island (Hillebrand 1888, p. 572; Medeiros et al. 1993, pp. 86-87; Palmer 2003, pp. 87-88) (USFWS, 2014; USFWS, 2016).

### **Current Range**

U.S., Hawaii: Island of Oahu, Honolulu County; Island of Maui, Maui County. Currently, *Cyclosorus boydiae* is found only at higher elevations on Oahu and east Maui, in 7 occurrences totaling approximately 400 individuals (Palmer 2003, pp. 87-88; Oppenheimer 2008, in litt.; Fay 2010, in litt.; HBMP 2010; Welton 2010, in litt.). On east Maui, there are 5 occurrences (approximately 360 individuals) in the lowland wet and montane wet ecosystems, and on Oahu, there are 2 occurrences in the Koolau Mountains in the montane wet ecosystem, totaling 40 individuals (Palmer 2003, pp. 87-88; Wood 2007, in litt.; Kam 2008, in litt.; Oppenheimer 2008 and 2010, in litt.; HBMP 2010; Welton 2010, in litt.; Ching 2011, in litt.). The historical occurrence of *C. boydiae* on the island of Hawaii was found in the lowland wet ecosystem (HBMP 2010) (USFWS, 2014; USFWS, 2016).

### **Critical Habitat Designated**

No;

### **Life History**

### **Food/Nutrient Resources**

**Habitat Type**

Adult: Typical habitat for this species is exposed, rocky, moss-covered banks of stream courses in dense wet *Metrosideros-Acacia* (ohia-koa) forest, with other ferns, grasses, and dwarfed woody species (Medeiros et al. 1993, p. 87) (USFWS, 2014; USFWS, 2015).

**Habitat Vegetation or Surface Water Classification**

Adult: Palustrine habitat: forested wetland, riparian. Terrestrial habitat: Forest - Hardwood, Forest/Woodland.

**Habitat Narrative**

Adult: Typical habitat for this species is exposed, rocky, moss-covered banks of stream courses in dense wet *Metrosideros-Acacia* (ohia-koa) forest, with other ferns, grasses, and dwarfed woody species (Medeiros et al. 1993, p. 87). When growing on streambanks, the plants are often growing in the zone right above the normal water level, and are inundated when the streams flood (USFWS, 2014; USFWS, 2015).

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

7 populations: 5 on Maui, 2 on Oahu (USFWS, 2014; USFWS, 2015)

**Population Size:**

~400 individuals (USFWS, 2014; USFWS, 2015)

**Population Narrative:**

Currently, *Cyclosorus boydiae* is found only at higher elevations on Oahu and east Maui, in 7 occurrences totaling approximately 400 individuals (Palmer 2003, pp. 87–88; Oppenheimer 2008, in litt.; Fay 2010, in litt.; HBMP 2010; Welton 2010, in litt.). On east Maui, there are 5 occurrences (approximately 360 individuals) in the lowland wet and montane wet ecosystems, and on Oahu, there are 2 occurrences in the Koolau Mountains in the montane wet ecosystem, totaling 40 individuals (Palmer 2003, pp. 87–88; Wood 2007, in litt.; Kam 2008, in litt.; Oppenheimer 2008 and 2010, in litt.; HBMP 2010; Welton 2010, in litt.; Ching 2011, in litt.). The historical occurrence of *C. boydiae* on the island of Hawaii was found in the lowland wet ecosystem (HBMP 2010). (USFWS, 2014; USFWS, 2015).

***Threats and Stressors***

**Stressor:** Habitat degradation and loss by feral pigs

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Hawaiian ecosystems, having evolved without hoofed mammals, are susceptible to large-scale disturbance by pigs and other introduced ungulates (Loope et al. 1991, p. 3). Because of demonstrated habitat modifications by feral pigs, such as destruction of native plants, disruption of topsoil leading to erosion, and establishment and spread of nonnative plants, the U.S. Fish and Wildlife Service (FWS) believes they are threats to *C. boydiae*.

**Stressor:** Habitat degradation, loss, and competition with nonnative plants

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Cyclosorus boydiae* is threatened by nonnative plant species that degrade and destroy habitat and outcompete native plants (HBMP 2008; Medeiros et al. 1993, pp. 88-89; Palmer 2003, p. 88). The nonnative plants that are the greatest threat to *C. boydiae* are: *Ageratina adenophora* (Maui pamakani), *Holcus lanatus* (common velvet grass), *Hypochoeris radicata* (hairy cats ear), and *Prunella vulgaris* (selfheal) at the Kipahulu Valley populations (Medeiros et al. 1993, p. 88; HBMP 2008); *Ageratina adenophora*, *Clidemia hirta* (Kosters curse), *Hedychium gardnerianum* (kahili ginger), *Paspalum urvillei* (vasey grass), *Prunella vulgaris*, *Rubus rosifolius* (thimbleberry), and *Tibouchina herbacea* (glorybush) at the east Kopiliula population (Wood, in litt. 2007); and *Clidemia hirta* and *Psidium cattleianum* at the Kawaiiki population (HBMP 2008).

### **Recovery**

#### **Recovery Actions:**

- Protect all individuals from feral pigs by removing pigs from areas where *C. boydiae* populations exist and preventing reinvasion through the use of exclosures.
- Control nonnative plants through physical, mechanical, and biological control methods, as well as herbicides when necessary. Continue to conduct research into potential biocontrol species.
- Conduct field surveys for additional populations in suitable *C. boydiae* habitat.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.
- Propagate and maintain genetic stock.

#### **Conservation Measures and Best Management Practices:**

- Protect all individuals from feral pigs by removing pigs from areas where *C. boydiae* populations exist and preventing reinvasion through the use of exclosures.
- Propagate and maintain genetic stock.
- Control nonnative plants through physical, mechanical, and biological control methods, as well as herbicides when necessary; continue to conduct research into potential biocontrol species.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

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**SPECIES ACCOUNT: *Deparia kaalaana* (No common name)**

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***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

**Physical Description**

Fronds (fern leaves) are 6 to 12 in (15 to 30 cm) long, sometimes bearing plantlets at the end of the rachis (the midrib of the fern blade, which is the expanded part of the frond above the stipe). Stipes (the stalk of the frond joining the stem to the blade) are strawcolored and sparsely scaly. Blades are oblong-lanceolate, with 9 to 11 pairs of pinnae. This species is distinguished from *D. marginalis* by its smaller, shortstalked and obliquely arranged pinnae, ultimate segments, and veins (Palmer 2003, pp. 109–111) (USFWS, 2015).

**Taxonomy**

*Deparia kaalaana* (Copel.) M. Kato is recognized as a distinct taxon by Palmer (2003, pp. 109111). (USFWS, 2014)

**Historical Range**

*Deparia kaalaana* is historically known from the islands of Maui, Hawaii, and Kauai (Palmer 2003, pp. 109111; Plant Extinction Prevention Program (PEPP) 2014, p. 91; PEPP 2014, in litt.). (USFWS, 2014; USFWS, 2015)

**Current Range**

Currently, there is one single known individual in Haleakala National Park on East Maui *D. kaalaana* (Palmer 2003, pp. 109111; PEPP 2014, p. 91; PEPP 2014, in litt.). (USFWS, 2014; USFWS, 2015)

**Critical Habitat Designated**

No;

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

Adult: Not available.

**Habitat Type**

Adult: Terrestrial, riparian (USFWS, 2014)

**Habitat Vegetation or Surface Water Classification**

Adult: Forest (USFWS, 2014)

**Habitat Narrative**

Adult: *Deparia kaalaana* is restricted to rocky banks of streams in wet forest (Palmer 2003, pp. 109111). (USFWS, 2014)

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends*****Population Trends:**

Not available.

**Resiliency:**

Very low (inferred from USFWS, 2014)

**Redundancy:**

Very low (inferred from USFWS, 2014)

**Number of Populations:**

1 (USFWS, 2014; USFWS, 2015)

**Population Size:**

1 (USFWS, 2014; USFWS, 2015)

**Population Narrative:**

This species was thought to be extinct on all three islands on which it previously occurred, until it was recently discovered on East Maui (Palmer 2003, pp. 109111). One individual was found in Haleakala National Park on East Maui (PEPP 2014, p. 91; PEPP 2014, in litt.). (USFWS, 2014). *Deparia kaalaana* was presumed extinct on all three islands where it previously occurred until one individual was discovered on east Maui, growing along a perennial stream on the western side of a small pool with other native ferns and herbaceous plants (Oppenheimer and Bustamente 2014, pp. 103–107; PEPP 2014, p. 95) (USFWS, 2015).

***Threats and Stressors*****Stressor:****Exposure:****Response:****Consequence:****Narrative:**

**Stressor:** Habitat changes (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** In addition, species restricted and adapted to highly specialized locations (e.g., *Deparia kaalaana*) are particularly vulnerable to changes (e.g., nonnative species, hurricanes, fire, and climate change) in their habitat (Carlquist and Cole 1974, pp. 2829; Loope 1992, pp. 36; Stone 1992, pp. 88102).

**Stressor:** Foraging and trampling by goats, pigs, black-tailed deer, axis deer, and mouflon sheep (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Foraging and trampling of native plants by goats (*Capra hircus*), pigs (*Sus scrofa*), black-tailed deer (*Odocoileus hemionus*), axis deer (*Axis axis*), and mouflon sheep (*Ovis gmelini musimon*) results in severe erosion of watersheds because these mammals inhabit terrain that is often steep and remote (Cuddihy and Stone 1990, p. 63). They destabilize soils that support native plant communities, bury or damage native plants, and adversely affect water quality due to runoff over exposed soils. They also destroy the seeds and seedlings of native plant species (Cuddihy and Stone 1990, p. 63), which facilitates the conversion of disturbed areas from native to nonnative vegetative communities. (USFWS, 2014)

**Stressor:** Soil disturbance by feral pigs (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Disturbance of soils by feral pigs creates fertile seedbeds for nonnative species (Cuddihy and Stone 1990, p. 65). (USFWS, 2014)

**Stressor:** Nutrient availability increases from pigs (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Nutrient availability increases as a result of pigs rooting in the nitrogen-poor soils, thus facilitating the establishment of nonnative invasive weeds. Invasive weeds are more adapted to nutrient rich soils than native plants (Cuddihy and Stone 1990, p. 63), and rooting activity creates open areas in forests allowing alien species to completely replace native stands. (USFWS, 2014)

**Stressor:** Rodent damage (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Rodents damage plant propagules, seedlings, or native trees, which changes forest composition and structure (Cuddihy and Stone 1990, p. 67). (USFWS, 2014)

**Stressor:** Defoliation by non-native insects (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Nonnative insects feed on and defoliate native plants which reduces the geographic range of some species (Cuddihy and Stone 1990, p. 71). Nonnative insects also predate native insect pollinators, which can affect the reproductive success of native plant species (Cuddihy and Stone 1990, p. 71). (USFWS, 2014)

**Stressor:** Changes in nutrient cycling by non-native invertebrates (USFWS, 2014)

**Exposure:**

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

**Narrative:** Large numbers of nonnative invertebrates such as earthworms, ants, slugs, isopods, millipedes, and snails can cause significant changes in nutrient cycling processes resulting in changes to the composition and structure of plant communities (Cuddihy and Stone 1990, p. 73). (USFWS, 2014)

**Stressor:** Competition for space by non-native plants (USFWS, 2014)

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

**Narrative:** Nonnative plants displace native Hawaiian species by competing for water, nutrients, light and space; or they may produce a chemical that inhibits growth of other plants (Smith 1985, pp. 180250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74). (USFWS, 2014)

**Stressor:** Climate change (USFWS, 2014)

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

**Narrative:** Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 73) concluded that *Deparia kaalaana* is moderately vulnerable to the impacts of climate change. Therefore, additional management actions may be needed to conserve this taxon into the future. (USFWS, 2014)

**Stressor:** Isolation (USFWS, 2014)

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

**Narrative:** Species that are endemic to single islands or small island groups are inherently more vulnerable to extinction than are widespread species because of the increased risk of genetic bottlenecks, random demographic fluctuations, climate change effects, and localized catastrophes such as hurricanes, drought, rockfalls, landslides, and disease outbreaks (Pimm. 1988, p. 757; Mangel and Tier 1994, p. 607). (USFWS, 2014)

**Stressor:** Small population size (USFWS, 2014)

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

**Narrative:** These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals in each population is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soule 1986, pp. 2434). (USFWS, 2014)

**Stressor:** Reduced genetic diversity (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (e.g., Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). (USFWS, 2014)

**Stressor:** Demographic fluctuations (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats (e.g., nonnative plants and animals, drought, or fire). (USFWS, 2014)

### ***Recovery***

**Reclassification Criteria:**

Not available.

**Delisting Criteria:**

Not available.

**Recovery Actions:**

- Not available.

### ***Conservation Measures and Best Management Practices:***

- Continue to survey for populations of *Deparia kaalaana* in areas of potentially suitable habitat. (USFWS, 2014)
- Begin propagation efforts for maintenance of genetic stock. (USFWS, 2014)
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species. (USFWS, 2014)

### **References**

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<http://ecos.fws.gov/ecp0/>. Accessed September 2016

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USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. Region 1 Pacific Islands Fish and Wildlife Office, Honolulu, Hawaii

## SPECIES ACCOUNT: *Diplazium molokaiense* (No common name)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 09/26/1994; Pacific Region (R1) (USFWS, 2016)

#### **Physical Description**

A fern with a short prostrate stem. Leaf stalks are 15 - 20 cm long and green or straw colored. Fronds are thin-textured, and 15 - 50 cm wide (NatureServe, 2015).

#### **Taxonomy**

The genus is indigenous to Hawaiian Islands, and the species is endemic to the Hawaiian islands (NatureServe, 2015). It is a member of the woodfern family (Dryopteridaceae) (USFWS, 1998).

#### **Historical Range**

Historically, *Diplazium molokaiense* was found at Kaholuamano on Kauai (Hill' 1995c7); Makaleha and Schofield Barracks on Oahu (Hill' 1995c2, 1995c3); Kalae, Kaluaaha, Mapulehu, and the Wailau Trail on Molokai (HHP 1995c5, 1995c1 1 to 1995c13); Mahana Valley and Kaiholena on Lanai (HHP 1995c8, 1995c9); and Ainahou Valley and Maliko Gulch (East Maui) and Wailuku (Iao) Valley and Waikapu on West Maui (HI-IP 1995c1, 1995c4) (USFWS, 1998).

#### **Current Range**

Current range is in Maui (NatureServe, 2015).

#### **Critical Habitat Designated**

Yes; 6/17/2003.

#### **Legal Description**

On March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Diplazium molokaiense*.

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Diplazium molokaiense* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Diplazium molokaiense* (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 6,573 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Diplazium molokaiense* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

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

#### **Critical Habitat Designation**

Maui—Lowland Wet—Unit 2, Maui— Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet— Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, Maui— Lowland Wet—Unit 8, Maui—Montane Wet—Unit 1, Maui—Montane Wet— Unit 2,

Maui—Montane Wet—Unit 3, Maui—Montane Wet—Unit 4, Maui—Montane Wet—Unit 5, Maui—Montane Mesic—Unit 1, Maui—Montane Mesic—Unit 2, Maui—Montane Mesic—Unit 3, Maui—Montane Mesic—Unit 4, Maui—Montane Mesic—Unit 5, Maui—Dry Cliff—Unit 1, Maui—Dry Cliff—Unit 2, Maui—Dry Cliff—Unit 3, Maui—Dry Cliff—Unit 4, Maui—Dry Cliff—Unit 5, and Maui—Dry Cliff—Unit 6 constitute critical habitat for *Diplazium molokaiense* on Maui. Molokai—Lowland Mesic—Unit 1 constitutes critical habitat for *Diplazium molokaiense* on Molokai.

Maui—Lowland Wet—Unit 2 consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriform*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendrion pyriform*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as

physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwiku* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

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

area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

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

Maui—Montane Wet—Unit 1 consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe

(*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. mcelandowneyi*, *Geranium hanaense*, *G. multiflorum*, and *Wikstroemia villosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea glabra*, *C. maritae*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, and *Schiedea jacobii*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*,

*Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *pentamera*, *B. campylothea* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *Cyanea duvalliorum*, *C. glabra*, *C. mceldowneyi*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plant *Bidens campylothea* ssp. *pentamera*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Bidens campylothea* ssp. *waihoiensis*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *M. ovalis*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations

within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium arboreum*, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylothea* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Cyanea glabra*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. mceldowneyi*, *Phyllostegia bracteata*, *P. mannii*, *Santalum haleakalae* var. *lanaiense*, *Wikstroemia villosa*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuehunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plant *Geranium hillebrandii*, and contain unoccupied habitat that is essential to the conservation of

this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although Maui—Dry Cliff—Unit 1 is not known to be occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the

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

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. It is occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Geranium multiflorum*, *Plantago princeps*, and *Schiedea haleakalensis*, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 2 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, or *Diplazium molokaiense*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 3 consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plant *Plantago princeps*, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although Maui—Dry Cliff—Unit 4 is not currently occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Bidens campylotheca* ssp. *pentamera*, *B. micrantha* ssp. *kalealaha*, *Diplazium molokaiense*, *Geranium multiflorum*, *Plantago princeps*, or *Schiedea haleakalensis*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical

range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

**Maui—Dry Cliff—Unit 5** This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. They are occupied by the plant *Tetramolopium capillare*, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, or *Neraudia sericea*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

**Maui—Dry Cliff—Unit 6** consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem. Although Maui—Dry Cliff—Unit 6 is not currently occupied by the plants *Bonamia menziesii*, *Diplazium molokaiense*, *Hesperomannia arbuscula*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Neraudia sericea*, or *Tetramolopium capillare*, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Diplazium molokaiense* includes 8 critical habitat units, covering two ecosystem types, which encompass approximately 6,573 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea.

The critical habitat designation for *Diplazium molokaiense* includes one CHU in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—*Diplazium molokaiense*—a: This unit is critical habitat for *Diplazium molokaiense* and is 430 ha (1,062 ac) on State land (Kuia NAR and Kokee State Park). This unit contains portions of Awaawapuhi, Honopu, and Nualolo Trails. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial *Diplazium molokaiense* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is essential to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, brown soil with basalt outcrops near waterfalls in lowland or montane mesic *Metrosideros polymorpha*-*Acacia koa* forest. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic

event. This fern species has wind-blown spores with limited opportunity for germination and growth. Therefore, this species requires large intact areas of land to support a viable population.

**Primary Constituent Elements/Physical or Biological Features**

(i) In units Maui—Lowland Wet— Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui— Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet— Unit 7, and Maui—Lowland Wet—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

(ii) In units Maui—Montane Wet— Unit 1, Maui—Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui— Montane Wet—Unit 4, and Maui— Montane Wet—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. (E) Subcanopy: Broussaia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

(iii) In units Maui—Montane Mesic— Unit 1, Maui—Montane Mesic—Unit 2, Maui—Montane Mesic—Unit 3, Maui— Montane Mesic—Unit 4, and Maui— Montane Mesic—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

(iv) In units Maui—Dry Cliff—Unit 1, Maui—Dry Cliff—Unit 2, Maui—Dry Cliff—Unit 3, Maui—Dry Cliff—Unit 4, Maui—Dry Cliff—Unit 5, and Maui— Dry Cliff—Unit 6, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

In unit Molokai—Lowland Mesic—Unit 1, the physical and biological features of critical habitat are:

(i) Elevation: Less than 3,300 ft (1,000 m).

(ii) Annual precipitation: 50 to 75 in (130 to 190 cm).

(iii) Substrate: Shallow soils, little to no herbaceous layer.

(iv) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum.

(v) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*.

(vi) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Diplazium molokaiense* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Diplazium molokaiense* was known historically (last observed > 20 yrs ago) from the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

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

(i) Brown soil with basalt outcrops near waterfalls in lowland or montane mesic *Metrosideros polymorpha*-*Acacia koa* forest; and

(ii) Elevations between 624 and 1,234 m (2,048 and 4,048 ft).

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of this species will continue to be degraded and destroyed.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Diplazium molokaiense* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat

destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

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

### ***Life History***

#### **Food/Nutrient Resources**

#### **Lifespan**

Adult: < 10 years (USFWS, 2014)

#### **Reproduction Narrative**

Adult: It is a short-lived perennial (fewer than 10 years), or a long-lived perennial (USFWS, 2014).

#### **Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

#### **Habitat Vegetation or Surface Water Classification**

Adult: Montane mesic ohia/koa forest (USFWS, 1998)

#### **Geographic or Habitat Restraints or Barriers**

Adult: 2,800 - 5,500 ft. elevation (USFWS, 1998)

#### **Habitat Narrative**

Adult: Inhabits moist forests (NatureServe, 2015). Recently known populations of *Diplazium molokaiense* were between 850 and 1,680 meters (2,800 and 5,500 feet) in elevation (HHP 1995c6, 1995c10) in lowland to montane habitat, including Montane Mesic Ohia/Koa Forest (USFWS 1994a) (USFWS, 1998).

### ***Dispersal/Migration***

#### **Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Increasing (USFWS, 2014)

**Resiliency:**

Very low (inferred from NatureServe, 2015; see current range/distribution)

**Redundancy:**

Low (inferred from USFWS, 2014)

**Number of Populations:**

3 (USFWS, 2014)

**Population Size:**

81 (USFWS, 2014)

**Population Narrative:**

Overall, the numbers of individuals have increased from approximately 65 individuals reported in the previous 5-year review to approximately 81 individuals in 2013 (PEPP 2012, 2013). The increase in numbers resulted from additional surveys and weed control. There are three known populations (USFWS, 2014).

***Threats and Stressors***

**Stressor:** Climate change (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *D. molokaiense* is moderately vulnerable to the impacts of climate change (USFWS, 2014).

**Stressor:** Habitat degradation (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** All Maui populations are threatened by erosion (PEPP 2009, 2013). Flooding events threaten all Maui populations of *D. molokaiense* (PEPP 2009, 2013) (USFWS, 2014).

**Stressor:** Stochastic events (USFWS, 2014)

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

**Narrative:** Drought may exacerbate the effects of ungulates and has direct adverse impacts on *D. molokaiense* (PEPP 2010, 2013). Fire is a threat to the Kula Forest Reserve population (PEPP 2009, 2013) (USFWS, 2014).

**Stressor:** Herbivory (USFWS, 2014)

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

**Narrative:** Herbivory by slugs have been reported impacting populations located at the Kula Forest Reserve (PEPP 2009, 2013) and at the Nakula Natural Area Reserve (PEPP 2012) (USFWS, 2014).

***Recovery*****Reclassification Criteria:**

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

**Delisting Criteria:**

1. A total of 8 to 10 populations of each taxon should be documented on islands where they now occur or occurred historically (USFWS, 1998).
2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (USFWS, 1998).
3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1998).

**Recovery Actions:**

- Protect habitat and control threats (USFWS, 1998).
- Expand current populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within the historic range (USFWS, 1998).
- Validate and revise recovery objectives (USFWS, 1998).
- Fencing and removal of ungulates from its habitat (USFWS, 1998).
- Control of competing alien plant species (USFWS, 1998).
- Ex situ propagation (USFWS, 1998).

- Protection and enhancement of the wild population (USFWS, 1998).

***Conservation Measures and Best Management Practices:***

- Captive propagation for genetic storage and reintroduction - Continue collecting material for genetic storage and propagation for reintroduction. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).
- Reintroduction / translocation – Augment current natural populations to increase numbers of individuals (USFWS, 2014).
- Ungulate monitoring and control – Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Control invasive introduced plant species within exclosures (USFWS, 2014).
- Surveys / inventories – Continue to survey the geographical and historical range of *D. molokaiense* for a thorough current assessment of the species' status (USFWS, 2014).
- Predator / herbivore monitoring and control – Control slugs within the vicinity of all known *D. molokaiense* populations (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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## SPECIES ACCOUNT: *Doryopteris angelica* (Digit fern)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

A fern (USFWS, 2016).

### **Taxonomy**

A member of the pteris family (Pteridaceae) (USFWS, 2016).

### **Historical Range**

Not available

### **Current Range**

Currently occurs in Awaawapuhi, Mahanalo, Makaha, Kuia, and Paaiki (NTBG 1998; Wagner [W.H.] et al. 1999b, p. 147; Wood 1999, 2000, 2007a; Perlman, in litt. 2006; HBMP 2007); on Kauai (USFWS, 2016).

### **Critical Habitat Designated**

Yes; 4/13/2010.

### **Legal Description**

On April 13, 2010, the U.S. Fish and Wildlife Service designated critical habitat for *Doryopteris angelica* (Digit fern) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Kauai County in Hawaii (75 FR 18960-19165).

### **Critical Habitat Designation**

Kauai 7–*Doryopteris angelica*–a and Kauai 11–*Doryopteris angelica*–b, constitute critical habitat for *Doryopteris angelica* on Kauai.

Lowland Mesic–Section 1 consists of 2,006 ac (812 ha) in the lowland mesic ecosystem, including mesic forest extending from Awaawapuhi Trail south to Makaha Ridge, in the Na Pali Kona Forest Reserve and the Kuia NAR. The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Doryopteris angelica*, *Labordia helleri*, *Platydesma rostrata* and *Psychotria hobbii*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations.

Lowland Mesic–Section 2 consists of 379 ac (154 ha) in the lowland mesic ecosystem, including mesic forest extending from Keanapuka to Kahuamaa Flat along the rim and cliffs of the Kalalau Valley, in the Na Pali Coast State Park. The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a.

This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *C. remyi* var. *remyi*, *Charpentiera densiflora*, *Pittosporum napaliense*, and *Psychotria hobdyi*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem. This section also contains unoccupied habitat that is essential to the conservation of these six species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 2 is not known to be occupied by the species *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Platydesma rostrata*, and *Tetraplasandra bisattenuata*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Lowland Mesic–Section 3 consists of 124 ac (50 ha) in the lowland mesic ecosystem, including mesic forest extending from Manono Ridge, Pohakuao Valley, to Kanakuu, within the Na Pali Coast State Park. The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plants *Canavalia napaliensis*, *Chamaesyce eleanoriae*, and *Charpentiera densiflora*, and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem. This section also contains unoccupied habitat that is essential to the conservation of these three species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic–Section 3 is not known to be occupied by the species *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Lowland Mesic–Section 4 consists of 81 ac (33 ha) in the lowland mesic ecosystem, including mesic forest at the head of the Hanakapiai Valley, in the Na Pali Coast State Park. The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 66a. This section is occupied by the plant *Charpentiera densiflora* and includes mesic forest, the moisture regime, and canopy, subcanopy, and understory native plant species identified as PCEs in the lowland mesic ecosystem. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Lowland Mesic–Section 4 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Chamaesyce remyi* var. *remyi*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, *Psychotria hobdyi*, and *Tetraplasandra bisattenuata*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of

these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Lowland Mesic–Section 5 consists of 37 ac (15 ha) in the lowland mesic ecosystem, including mesic forest on the slopes of Mt. Haupu, on privately owned land. The entire section is within previously designated critical habitat, and falls within Critical Habitat Unit 7 of 50 CFR 17.99(a)(1), Map 23a. This section is occupied by the plants *Chamaesyce remyi* var. *remyi* and *Tetraplasandra bisattenuata*, and includes mesic forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as PCEs in the lowland mesic ecosystem. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Lowland Mesic– Section 5 is not known to be occupied by the species *Canavalia napaliensis*, *Chamaesyce eleanoriae*, *Charpentiera densiflora*, *Doryopteris angelica*, *Dubautia kenwoodii*, *Labordia helleri*, *Pittosporum napaliense*, *Platydesma rostrata*, and *Psychotria hobdyi*, the Service has determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

**Primary Constituent Elements/Physical or Biological Features**

Within these units, the primary constituent elements of critical habitat are:

- (i) Elevation: Less than 3,000 ft (914 m).
- (ii) Annual precipitation: 50 to 75 inches (127 to 190 centimeters).
- (iii) Substrate: Shallow soils, little to no herbaceous layer.
- (iv) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*.
- (v) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*.

**Special Management Considerations or Protections**

The primary threats to the physical and biological features essential to the conservation of this species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas.

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Acacia koa-Metrosideros polymorpha lowland mesic forest (USFWS, 2010b).

**Geographic or Habitat Restraints or Barriers**

Adult: 1,900 - 3,000 ft. elevation (USFWS, 2010b)

**Habitat Narrative**

Adult: Found on steep slopes in mesic forests. 800-980 m (NatureServe, 2015). It is found in Acacia koa–Metrosideros polymorpha lowland mesic forest in the lowland mesic ecosystem at elevations between roughly 1,900 and 3,000 ft. (579 and 914 m) (HBMP 2007; TNCH 2007) (USFWS, 2010b).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Resiliency:**

Very low (inferred from USFWS, 2016; see current range/distribution)

**Redundancy:**

Low (inferred from USFWS, 2010a)

**Number of Populations:**

5 (USFWS, 2010a)

**Population Size:**

29 - 54 (USFWS, 2010a). Currently, fewer than 250 individuals of *Doryopteris angelica* persist at eight locations. A new population of five individuals was discovered at Makaha (PEPP 2015). Spore collecting and propagation efforts are ongoing, and 17 individuals have been outplanted in a fenced enclosure at Paaiki (USFWS, 2017).

**Population Narrative:**

There are five populations containing 29 - 54 individuals (USFWS, 2010a).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

**Stressor:** Predation and herbivory (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Predation and herbivory by nonnative animal species present an immediate and significant threat to *Doryopteris angelica* throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

**Stressor:** Small populations (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Doryopteris angelica* is threatened by the effects of small population size (fewer than 50 wild individuals). Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

**Recovery****Reclassification Criteria:**

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

**Delisting Criteria:**

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

**Recovery Actions:**

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape

modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).

- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).

***Conservation Measures and Best Management Practices:***

- The Plant Extinction Prevention Program focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010a).
- RECOMMENDATIONS FOR FUTURE ACTIONS: • Surveys and inventories—Survey suitable habitat within historic range for additional individuals. • Ungulate monitoring and control—Construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore monitoring and control—Implement effective measures to control rodents around all known populations. • Captive propagation for genetic storage and reintroduction—Continue spore collection with complete representation of remaining individuals and establish secure ex situ stocks. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Genetic research—Map genetic diversity in the surviving populations to guide future reintroduction and augmentation efforts and survey ex-situ holdings and conduct molecular fingerprinting. • Population biology research—Study *Doryopteris angelica* populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting

factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

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## **SPECIES ACCOUNT: *Doryopteris takeuchii* (No common name)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 10/18/2012; Pacific Region (R1) (USFWS, 2016)

#### **Physical Description**

A small tufted terrestrial fern. Fronds are elliptic-deltate to elliptic, 10 - 25 x 3 - 8 cm including the stipe (NatureServe, 2015).

#### **Taxonomy**

A member of the Pteridaceae family (Palmer 2003, p. 133) (USFWS, 2012). Likely to be confused with *Cheilanthes* (= *Doryopteris*) *decipiens*. The U.S. Fish and Wildlife Service uses the name *Doryopteris takeuchii*. *Doryopteris takeuchii* is recognized in Kartesz (1999) (NatureServe, 2015).

#### **Historical Range**

Little is known of the historical distribution of *D. takeuchii* (USFWS, 2012).

#### **Current Range**

Known only from the volcanic cone Leahi (Diamond Head Crater) on the island of Oahu, State of Hawaii (Palmer 2003) (NatureServe, 2015).

#### **Critical Habitat Designated**

Yes; 9/18/2012.

#### **Legal Description**

On September 18, 2012, the U.S. Fish and Wildlife Service designated critical habitat for *Doryopteris takeuchii*.

#### **Critical Habitat Designation**

Oahu—Lowland Dry—Unit 6 and Oahu—Lowland Dry—Unit 7 constitute critical habitat for *Doryopteris takeuchii* on Oahu.

Oahu—Lowland Dry—Unit 6 consists of 287 ac (116 ha) of State land in the lowland dry ecosystem, on the outer rim of Leahi (Diamond Head) Crater within Diamond Head State Monument. This unit is occupied by the plants *Doryopteris takeuchii* and *Spermolepis hawaiiensis*, and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Lowland Dry—Unit 7 consists of 15 ac (6 ha) of State land in the lowland dry ecosystem, in Leahi (Diamond Head) Crater within Diamond Head State Monument. This unit is occupied by the plant *Cyperus trachysanthos* and includes the dry forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland dry ecosystem, as well as unique PCEs for this plant. This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the

PCEs necessary for the expansion of the existing wild populations. Although Oahu—Lowland Dry—Unit 7 is not known to be occupied by the plants *Doryopteris takeuchii*, *Gouania meyenii*, *Marsilea villosa*, or *Spermolepis hawaiiensis*, the Service has determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species, and the unique PCEs for the species *M. villosa* (see Table 5). Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

**Primary Constituent Elements/Physical or Biological Features**

Within these units, the physical and biological features of critical habitat are:

- (i) Elevation: Less than 3,300 ft (1,000 m).
- (ii) Annual precipitation: Less than 50 in (130 cm).
- (iii) Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava.
- (iv) Canopy: *Diospyros*, *Myoporum*, *Pleomele*, *Santalum*, *Sapindus*.
- (v) Subcanopy: *Chamaesyce*, *Dodonaea*, *Leptecophylla*, *Osteomeles*, *Psydrax*, *Scaevola*, *Wikstroemia*.
- (vi) Understory: *Alyxia*, *Artemisia*, *Bidens*, *Chenopodium*, *Nephrolepis*, *Peperomia*, *Sicyos*.

**Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas.

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial (USFWS, 2012)

**Habitat Vegetation or Surface Water Classification**

Adult: Dry shrubland (USFWS, 2012)

**Geographic or Habitat Restraints or Barriers**

Adult: 140 - 300 ft. elevation (USFWS, 2012)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: It occurs in dry shrubland on the slopes of Diamond Head Crater, at elevations between 140 and 300 ft. (43 and 91 m) (NTBG 2007a, p. 1). This area consists of pockets of native and nonnative species in the lowland dry ecosystem (TNC 2007) (USFWS, 2013). 101 to 124 clumps of plants have been observed. The environmental specificity is very narrow; all individuals occur upon dry volcanic tuff slopes (NatureServe, 2015).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

30 - 50% decline (NatureServe, 2015)

**Resiliency:**

Very low (inferred from NatureServe, 2015; see current range/distribution)

**Redundancy:**

Very low (inferred from NatureServe, 2015)

**Number of Populations:**

1 - 3 (NatureServe, 2015)

**Population Size:**

160 - 200 (USFWS, 2012)

**Population Narrative:**

There is currently a total of 160 to 200 individuals on Diamond Head (NTBG 2007, p. 1; Lau 2011, in litt.) (USFWS, 2012). There are three current occurrences (2007) all located at a single dormant volcanic crater. This species has experienced a long term decline of 30 - 50%; it is suspected that this species evolved relatively recently and never had a wide historic distribution on Oahu, but the magnitude of the threats facing the species has increased dramatically (Russell 2002) (NatureServe, 2015).

***Threats and Stressors***

**Stressor:** Habitat destruction or modification (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Adverse impacts on habitat of this species have been identified from nonnative plants, fire, rockfalls, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds as well as the plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants, and remove habitat for native species by altering microclimate conditions favorable to alien plants. Rockfalls and landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

**Stressor:** Trampling by humans (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Doryopteris takeuchii* faces the threat of trampling. *D. takeuchii* occurs on the slopes of Diamond Head crater, a popular location for visitation by tour groups and hikers. Individuals leaving established trails will inadvertently trample plants and contribute to erosion of the steep hillsides where the plants are found (USFWS, 2012).

**Stressor:**

**Exposure:**

**Response:**

**Consequence:**

**Narrative:**

**Stressor:**

**Exposure:**

**Response:**

**Consequence:**

**Narrative:**

***Recovery*****Reclassification Criteria:**

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

**Delisting Criteria:**

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

**Recovery Actions:**

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

***Conservation Measures and Best Management Practices:***

- Not available

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Final Rule. 77 Federal Register 181, September 18, 2012. Pages 57648 - 57862.

## SPECIES ACCOUNT: *Dryopteris crinalis* var. *podosorus* (Palapalai aumakua)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 05/13/2010; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

Stems are short and upright. Fronds are upright and spreading. Blades elongate deltate, 12 - 35 cm long. Stipes and rachises with scattered brown hair-like scales (NatureServe, 2015).

### **Taxonomy**

Accepted by Kartesz (1999 checklist) (NatureServe, 2015). A member of the dryopteris family Dryopteridaceae) (USFWS, 2016).

### **Historical Range**

Historically, this variety was known from the Kokee area, Kawaikoi, and Waialeale (Palmer 2003, p. 139) (USFWS, 2016).

### **Current Range**

Currently, populations occur in Mohihi, south Kilohana, and Waialeale; Kauai (USFWS, 2016).

### **Critical Habitat Designated**

Yes; 4/13/2010.

### **Legal Description**

On April 13, 2010, the U.S. Fish and Wildlife Service designated critical habitat for *Dryopteris crinalis* var. *podosorus* (Palapalai aumakua) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in Kauai County in Hawaii (75 FR 18960-19165).

### **Critical Habitat Designation**

Kauai 10—*Dryopteris crinalis* var. *podosorus*—a, Kauai 11—*Dryopteris crinalis* var. *podosorus*—b, Kauai 23— *Dryopteris crinalis* var. *podosorus*—c, Kauai 24—*Dryopteris crinalis* var. *podosorus*—d, and Kauai 25—*Dryopteris crinalis* var. *podosorus*—e constitute critical habitat for *Dryopteris crinalis* var. *podosorus* on Kauai.

Montane Wet—Section 1 consists of 13,055 ac (5,257 ha) in the montane wet ecosystem, extending across the Alakai Plateau from Hanakoa to Mount Waialeale, on State (12,628 ac, 5,110 ha) and privately owned (427 ac, 173 ha) land in the Na Pali Coast State Park, the Alakai Wilderness Preserve, the Na Pali Kona and Halelea forest reserves, and Hono o Na Pali NAR. It is occupied by the plants *Astelia waialealae*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialealae*, *Geranium kauaiense*, *Keysseria erici*, *K. helenae*, *Labordia helleri*, *L. pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, and *Platydesma rostrata*; by the akekee and akikiki; and by the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of

these 18 species by providing the physical and biological features necessary for the expansion of the existing wild populations.

Montane Wet–Section 2 consists of 790 ac (320 ha) in the montane wet ecosystem, extending from Kahuamaa Flat south to the edge of Waimea Canyon, on State-owned land in Kokee State Park. The entire section is within previously designated critical habitat, and is occupied by the plants *Chamaesyce remyi* var. *remyi*, *Dubautia kalalauensis*, *Labordia helleri*, *Melicope puberula*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*, and by the akekee. This section includes montane wet forest, potentially some small-scale boggy areas, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the montane wet ecosystem, and arthropod prey (identified as a species-specific PCE for the akekee). Although Montane Wet–Section 2 is not known to be occupied by the plants *Astelia waialeale*, *Dryopteris crinalis* var. *podosorus*, *Dubautia waialeale*, *Geranium kauaiense*, *Keysseria erici*, *Keysseria helenae*, *Labordia pumila*, *Lysimachia daphnoides*, *Melicope degeneri*, *Myrsine mezii*, and *Phyllostegia renovans*; by the akikiki; or by the picture-wing fly, *Drosophila sharpi*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range.

Montane Wet–Section 3 consists of 413 ac (167 ha) in the montane wet ecosystem, encompasses the summit of Namolokama, on State (156 ac, 63 ha) and privately owned (257 ac, 104 ha) land in the Halelea Forest Reserve. It is entirely within previously designated critical habitat, and is occupied by the plants *Keysseria erici* and *Labordia pumila*. This section includes the montane wet forest, the moisture regime, and the canopy, subcanopy, and understory plant species identified as PCEs in the montane wet ecosystem, and bogs (identified as a species-specific PCE for *K. erici*). Although Montane Wet–Section 3 is not known to be occupied by the plants *Astelia waialeale*, *Chamaesyce remyi* var. *remyi*, *Dryopteris crinalis* var. *podosorus*, *Dubautia kalalauensis*, *D. waialeale*, *Geranium kauaiense*, *Keysseria helenae*, *Labordia helleri*, *Lysimachia daphnoides*, *Melicope degeneri*, *M. puberula*, *Myrsine mezii*, *Phyllostegia renovans*, *Platydesma rostrata*, *Psychotria grandiflora*, and *Tetraplasandra flynnii*; by the akekee and akikiki; or by the picture-wing fly, *Drosophila sharpi*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range.

#### **Primary Constituent Elements/Physical or Biological Features**

Within these units, the primary constituent elements of critical habitat are:

- (i) Elevation: 3,000 to 5,243 ft (914 to 1,598 m).
- (ii) Annual precipitation: Greater than 75 inches (190 centimeters).
- (iii) Substrate: Well-developed soils, montane bogs.
- (iv) Canopy: *Acacia*, *Charpentiera*, *Cheirodendron*, *Metrosideros*.
- (v) Subcanopy: *Broussaisia*, *Cibotium*, *Eurya*, *Ilex*, *Myrsine*.

(vi) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

**Special Management Considerations or Protections**

The primary threats to the physical and biological features essential to the conservation of this species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas.

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial, riparian (USFWS, 2010b)

**Habitat Vegetation or Surface Water Classification**

Adult: Metrosideros polymorpha montane wet forest (USFWS, 2010b).

**Geographic or Habitat Restraints or Barriers**

Adult: 4,000 - 5,100 ft. elevation (USFWS, 2010b)

**Habitat Narrative**

Adult: It is known from steep to vertical riparian basalt walls within dark seeping drainages in Metrosideros polymorpha montane wet forest within the montane wet ecosystem, from 4,000 to 5,100 ft. (1,200 to 1,550 m) in elevation (TNCH 2007; Wood 2007a) (USFWS, 2010b).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Resiliency:**

Very low (inferred from USFWS, 2016; see current range/distribution)

**Redundancy:**

Low (inferred from USFWS, 2010b)

**Number of Populations:**

3 (USFWS, 2010b)

**Population Size:**

32 - 47 (USFWS, 2010b)

**Population Narrative:**

Currently, 3 populations totaling 32 to 47 individuals are known (USFWS, 2010b).

**Threats and Stressors**

**Stressor:** Habitat destruction or modification (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Adverse impacts on habitat of this species have been identified from non-native plants, pigs, hurricanes, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species.

**Stressor:** Small populations (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Dryopteris crinalis* var. *podosorus* is threatened by the effects of small population size (fewer than 50 wild individuals). Research on *Pittosporum* species suggests that small populations are susceptible to loss of genetic variation through inbreeding and drift (USFWS, 2010).

**Stressor:**

**Exposure:**

**Response:**

**Consequence:**

**Narrative:**

**Recovery****Reclassification Criteria:**

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

**Delisting Criteria:**

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

**Recovery Actions:**

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).
- Identify threats and prioritize which ones to address first for the two birds (USFWS, 2010a).
- Determine if a captive propagation program for the two birds is necessary; if so, develop a captive propagation program (USFWS, 2010a).
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).

***Conservation Measures and Best Management Practices:***

- The Plant Extinction Prevention Program focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010a).
- RECOMMENDATIONS FOR FUTURE ACTIONS: • Surveys and inventories—Survey suitable habitat within historic range for additional individuals. • Ungulate monitoring and control—Control ungulates within *Dryopteris crinalis* var. *podosorus* habitat. Small-scale fencing should be considered around the few remaining individuals to prevent imminent extinction. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Captive propagation protocol development—Develop proper horticultural protocols

for spore collection and propagation. • Reintroduction and translocation—Augment wild populations and establish new populations within protected areas of suitable habitat. • Genetic research—Map genetic diversity in the surviving populations and ex situ holdings to guide future reintroduction and augmentation efforts. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).

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## SPECIES ACCOUNT: *Dryopteris glabra* var. *pusilla* (Kauai) (Kilau)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

*Dryopteris glabra* var. *pusilla* (hohiu) is a small, terrestrial fern in the wood fern family (Dryopteridaceae). Fronds are 1.5 to 12 in (4 to 30 cm) long and densely clustered, with very thin stipes, and fertile when small. Blades are 2- to 3-pinnate, with winged rachises, and marginal to submarginal sori (clusters of sporangia, the spore-bearing (reproductive) structures of ferns, along the blade edge) (USFWS, 2015).

### **Taxonomy**

Palmer (2003) lumps *Dryopteris tenebrosa* and *Dryopteris parvula* into *D. glabra* var. *pusilla*. *D. tenebrosa* and *D. parvula* are considered distinct species by Kartesz (1999). USFWS recognizes *D. glabra* var. *pusilla*. (NatureServe, 2015)

### **Historical Range**

This species is known from the Kawaikoi Stream, Waiakoali Stream, and Alakai Swamp trail, in Kokee State Park, on the island of Kauai (PEPP 2014, in litt.; Smithsonian Institute 2014 Online Herbarium Database). (USFWS, 2014; USFWS, 2015))

### **Current Range**

This species is currently known from the Kawaikoi Stream, Waiakoali Headwaters, and Alakai Swamp trail, in Kokee State Park, on the island of Kauai (PEPP 2014, in litt.; Smithsonian Institute 2014 Online Herbarium Database). (USFWS, 2014)

### **Critical Habitat Designated**

No;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproduction Narrative**

Adult: Not available.

### **Habitat Type**

Adult: Terrestrial and palustrine (NatureServe, 2015)

### **Habitat Vegetation or Surface Water Classification**

Adult: Forested wetland and riparian (NatureServe, 2015)

### **Geographic or Habitat Restraints or Barriers**

Adult: Found at locations around 1,200 meters (3,937 feet); prefers rocky, steep, wet, mossy streambanks (USFWS, 2014)

**Environmental Specificity**

Adult: Medium, with some key requirements (USFWS, 2014)

**Habitat Narrative**

Adult: Habitat for *Dryopteris glabra* var. *pusilla* is deep shade on rocky, mossy streambanks in wet forest at about 4,000 ft (1,200 m), in the montane wet ecosystem on Kauai (Palmer 2003, p. 144; TNCH 2007; HBMP 2010) (USFWS, 2015).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends*****Population Trends:**

Not available.

**Resiliency:**

Very low (inferred from USFWS, 2014)

**Redundancy:**

Very low (inferred from USFWS, 2014)

**Number of Populations:**

1 (USFWS, 2014)

**Population Size:**

60-70 (USFWS, 2014); <250 (USFWS, 2015)

**Population Narrative:**

This species is known from two subpopulations totaling 60 to 70 individuals in the Kawaikoi area in Kokee State Park, on the island of Kauai (PEPP 2014, in litt.). (USFWS, 2014). Currently, this species is known from fewer than 250 individuals in the Alakai Wilderness Preserve (including the Kawaiko stream area) on Kauai (National Tropical Botanical Garden (NTBG) Herbarium Database 1995, in litt.; HBMP 2010) (USFWS, 2015).

***Threats and Stressors***

**Stressor:** Foraging and trampling by feral ungulates (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Foraging and trampling of native plants by goats (*Capra hircus*), pigs (*Sus scrofa*), and axis deer (*Axis axis*) results in severe erosion of watersheds because these mammals inhabit terrain that is often steep and remote (Cuddihy and Stone 1990, p. 63). They destabilize soils that support native plant communities, bury or damage native plants, and adversely affect water quality due to runoff over exposed soils. They also destroy the seeds and seedlings of native

plant species (Cuddihy and Stone 1990, p. 63), which facilitates the conversion of disturbed areas from native to nonnative vegetative communities. (USFWS, 2014)

**Stressor:** Soil disturbances by pigs (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Disturbance of soils by feral pigs creates fertile seedbeds for nonnative species (Cuddihy and Stone 1990, p. 65). (USFWS, 2014)

**Stressor:** Nutrient increases by pigs (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Nutrient availability increases as a result of pigs rooting in the nitrogen-poor soils, thus facilitating the establishment of nonnative invasive weeds. Invasive weeds are more adapted to nutrient rich soils than native plants (Cuddihy and Stone 1990, p. 63), and rooting activity creates open areas in forests allowing alien species to completely replace native stands. (USFWS, 2014)

**Stressor:** Predation by rodents (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Rodents damage plant propagules, seedlings, or native trees, which changes forest composition and structure (Cuddihy and Stone 1990, p. 67). (USFWS, 2014)

**Stressor:** Predation by non-native insects (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Non-native insects feed on and defoliate native plants which reduces the geographic range of some species (Cuddihy and Stone 1990, p. 71). Nonnative insects also predate native insect pollinators, which can affect the reproductive success of native plant species (Cuddihy and Stone 1990, p. 71). (USFWS, 2014)

**Stressor:** Changes in nutrient cycling by non-native invertebrates (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Large numbers of non-native invertebrates such as earthworms, ants, slugs, isopods, millipedes, and snails can cause significant changes in nutrient cycling processes resulting in changes to the composition and structure of plant communities (Cuddihy and Stone 1990, p. 73). (USFWS, 2014)

**Stressor:** Isolation (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Species that are endemic to single islands or small island groups are inherently more vulnerable to extinction than are widespread species because of the increased risk of genetic bottlenecks, random demographic fluctuations, climate change effects, and localized catastrophes such as hurricanes, drought, rockfalls, landslides, and disease outbreaks (Pimm. 1988, p. 757; Mangel and Tier 1994, p. 607). (USFWS, 2014)

**Stressor:** Small population size (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals in each population is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soule 1986, pp. 2434). (USFWS, 2014)

**Stressor:** Reduced genetic diversity (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (e.g., Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). (USFWS, 2014)

**Stressor:** Demographic fluctuations (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats (e.g., nonnative plants and animals, drought, or fire). (USFWS, 2014)

### ***Recovery***

**Reclassification Criteria:**

Not available.

**Delisting Criteria:**

Not available.

**Recovery Actions:**

- Not available.

### ***Conservation Measures and Best Management Practices:***

- Continue to survey for populations of *Dryopteris glabra* var. *pusilla* in areas of potentially suitable habitat. (USFWS, 2014)

- Begin propagation efforts for maintenance of genetic stock. (USFWS, 2014)
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species. (USFWS, 2014)

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## SPECIES ACCOUNT: *Elaphoglossum serpens* (No common name)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 6/9/1993; Southeast Region (Region 4) (USFWS, 2015)

### **Physical Description**

an epiphytic fern with a wide-creeping, 1.5- to 2-mm-thick rhizome. The apex and nodes bear lanceolate to attenuate, 3- to 4-mm-long, lustrous, reddish-brown scales which have ciliate margins. This species has only a few, distant, and erect fronds. Sterile fronds are 7 to 19 cm long and the stipes, from 3.5 to 11 cm in length, are usually as long or longer than the blades. The blades are ovate, 3.5 to 8 cm long and 2 to 3.5 cm broad, obtuse at the apex, and cuneate at the base. The veins are free, reaching the margins of the blades. The coriaceous tissue is opaque with only scattered scales on the abaxial side. The fertile fronds are 8.5 to 18 cm long, and in contrast to the sterile fronds, the stipes are about three times longer than the blades. The blades are 2.5 to 4 cm long and 1 to 1.5 cm broad, and are lanceolate to elliptic-oblong with rounded or blunt apex (Proctor 1989). (USFWS, 1994)

### **Historical Range**

The epiphytic fern *E. serpens* is historically known from only two sites on the highest peaks of the Puerto Rico's Central Mountain Range: Cerro Punta (elevation 4,390 ft (1,340 m)), and Monte Jayuya (elevation 4,314 ft (1,315 m)) (Proctor 1991). These peaks are located within the Toro Negro Commonwealth Forest (Proctor 1991) (USFWS 1995). Specific number of individuals for the population at Monte Jayuya has never been determined nor has it been visited since Proctor in 1991. For Cerro Punta, Proctor (1991) reported a population estimate of at least 22 individuals. Nevertheless, despite recent efforts in 2016 and 2017 by staff from the Fairchild Tropical Botanic Garden (Fairchild) and the Service, the species has not been found in Cerro Punta or Monte Jayuya (Possley and Lange 2016, 2017). It appears that activities related to the construction and maintenance of communication towers on these peaks has impacted the species' habitat, abundance, and distribution (USFWS 2010, Monsegur-Rivera 2018, pers. comm.) (USFWS, 2019).

### **Current Range**

Found at a single site in the montane dwarf forest of the summit of Cerro Punta in the central mountains, municipality of Jayuya. (USFWS, 1994)

### **Critical Habitat Designated**

Yes;

### **Life History**

### **Food/Nutrient Resources**

### **Reproduction Narrative**

Adult: Not available

### **Habitat Type**

Adult: Terrestrial (EPA, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Subtropical lower montane wet forest (EPA, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: Elevations greatly above or below 4264 ft. (EPA, 2016)

**Spatial Arrangements of the Population**

Adult: Clumped (inferred from USFWS, 2010)

**Environmental Specificity**

Adult: Very narrow (inferred from USFWS, 2010)

**Dependency on Other Individuals or Species for Habitat**

Adult: *Lyonia rubiginosa* var. *stahlia* (USFWS, 2010)

**Habitat Narrative**

Adult: Occurs in montane dwarf forest (also called elfin forest and cloud forest) of the summit of Cerro Punta in Toro Negro Commonwealth Forest. Described as the subtropical lower montane wet forest life zone. Vegetation is characterized by a single canopy layer that is usually 22 ft. or less in height. The trees form a thick canopy and mosses, liverworts, and bromeliads are abundant. Occurs at elevations around 4264 ft. (1300 m) (EPA, 2016). All individuals occur on the mossy trunks of 6 trees of *Lyonia rubiginosa* var. *stahlia* (epiphytic) (USFWS, 2010).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Unknown (USFWS, 2010)

**Resiliency:**

Very low (inferred from USFWS, 2010)

**Representation:**

Very low (inferred from USFWS, 2010)

**Redundancy:**

Very low (inferred from USFWS, 2010)

**Number of Populations:**

1 (USFWS, 2010)

**Population Size:**

22 (USFWS, 2010)

**Population Narrative:**

The species status is uncertain; no recent surveys have been conducted and the current population numbers are not known. There is one locality for *Elaphoglossum serpens* with approximately 22 individual plants in Cerro Punta in Jayuya (USFWS, 2010).

**Threats and Stressors**

**Stressor:** Habitat destruction and modification (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Although the area where *Elaphoglossum serpens* historical population occurs is located within a Commonwealth forest, permit requests to build new communication facilities or expand currently existing ones are prevalent. The Puerto Rico Department of Natural and Environmental Resources is recommending monopole, multiple-use towers, as a habitat conservation measure, whenever possible instead of constructing new towers and antennae (Gerardo Hernández, PRDNER, pers. comm., 2007). *Elaphoglossum serpens* is also threatened by unplanned forest management practices conducted in Commonwealth forests (USFWS, 2010).

**Stressor:** Small population size (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Small population numbers makes this species particularly vulnerable to extinction due to the lack of genetic variation necessary to evolve and respond to natural changes. The best available information collected for *E. serpens* showed only 22 individuals all occurring on the mossy trunks of 6 trees of *Lyonia rubiginosa* var. *stahlia* (present in one of its few known localities) in Cerro Punta, Jayuya (USFWS, 2010).

**Recovery****Reclassification Criteria:**

1. The known populations are placed under protective status (USFWS, 2010).
2. An agreement within the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) concerning the protection of the three of the seven species in Commonwealth forests has been developed and implemented (USFWS, 2010).
3. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 2010).

**Delisting Criteria:**

The amended delisting criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* are as follows: 1. Existing populations (number populations in parentheses) of *E. Serpens* (2), *P. calderonenses* (3), *T. estremerana* (3), *T. verecunda* (3), *Tinabonensis* (2) and *T. yaucoensis* (2) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and Factor E). 2. Establish or discover new populations (number of populations in parentheses) within the historical range of *E. serpens* (3), *T. inabonensis* (3), *T. yaucoensis* (3), *P. calderonense* (2), *T. estremerana* (2), and *T. verecunda* (2) that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and 3. Threat reduction and management activities have been implemented to a degree that the species is viable for the foreseeable future (addresses Factor A and E) (USFWS, 2019).

#### **Recovery Actions:**

- Prevent further habitat loss and population decline (USFWS, 1994).
- Continue to gather information on the distribution and abundance (USFWS, 1994).
- Conduct research on habitat requirements, reproductive biology, and ecology of the seven species (USFWS, 1994).
- Establish new populations (USFWS, 1994).
- Refine recovery goals (USFWS, 1994).

#### **Conservation Measures and Best Management Practices:**

- Evaluate abundance and distribution of *Elaphoglossum serpens* through surveys within traditional and non-traditional sites, using the best available plant survey methodology to determine current population numbers, and number of viable populations necessary to protect and stabilize these three fern populations (wild, naturally reproducing populations large enough to maintain sufficient genetic variation, and evolve and respond to natural habitat changes) (USFWS, 2010).
  - Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects of construction/improvement of communication facilities and forest management practices in Commonwealth forests (USFWS, 2010).
  - Review and modify the Puerto Rican Endangered Ferns Recovery Plan which includes this species to establish delisting criteria. Recovery tasks should be reviewed and implemented (USFWS, 2010).
  - Propagation techniques should be developed for this species to establish new self sustainable populations in protected areas (USFWS, 2010).
  - Considering all these factors, we recommend the following:
    - The habitat of the two (2) known populations of *E. serpens* occurring on protected land (i.e., Cerro Punta and Monte Jayuya) need to be fully assessed, and populations enhanced to ensure their resiliency. Specifically, Possley and Lange (2017), and Service biologist O. Monsegur-Rivera recommend a more comprehensive survey that covers a wider area and expands away from the summit of Cerro Punta, a currently very disturbed area where the species was once found. Additionally, three (3) new populations of *E. serpens* should be established within the Toro Negro Commonwealth Forest or a similar protected habitat (e.g., Monte Guilarte), which genetically represent the known natural populations. Since this is an epiphytic plant, the protection of forest stands that harbor *E. serpens* common host trees, (e.g., *Lyonia Rubiginosa* var. *stahlii*), is also important in order to ensure the species' viability (USFWS, 2019).
- ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS 1. Genetic material from all species should be preserved through long-term spore storage and/or propagation efforts in institutions

authorized by the Service. Priority species for this action are *E. serpens*, *P. calderonense*, and *T. inabonensis* because their taxonomy is not in question. This recovery action should be added to recovery action 33. 2. Establishing new populations outside the current range needs a monitoring and propagation protocol, and pilot studies to ensure appropriate planting sites. To be added to the recovery action 4 (41). 3. Since most agreements and conservation efforts are associated with other Service branches or partner organizations, careful planning for conservation and management needs to be developed and should include partners' education. To be added to recovery action 1 (14). 4. Implement fire and invasive plant species management and control protocols at disturbed areas. This should be added as a new action in the recovery plan (USFWS, 2019).

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and Wildlife Service Southeast Region Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

## **SPECIES ACCOUNT: *Huperzia (=Phlegmariurus) mannii* (Wawae`iole)**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 05/12/1992; Pacific Region (R1) (USFWS, 2014)

### **Physical Description**

An epiphytic, pendent clubmoss (not rooted in the ground and not a parasite) hanging firmoss. Leafy stems are 4-10 cm long. Fruiting spikes branch 4-6 times and are 12-20 cm long.

### **Taxonomy**

In 2012, USFWS proposed to revise the taxonomic status for this species when it proposed to revise critical habitat designations on Maui, Lanai, Kahoolawe, and Molokai (USFWS 2012). The proposed change will consolidate the entries for *Huperzia mannii* and *Phlegmariurus mannii*. The proposed change will also remove the entry for *P. mannii* and recognize the listed species as *H. mannii*. The range of the species has not changed. The recognition and official change by USFWS of *H. mannii* will be finalized in the final rule for critical habitat designations on Maui, Lanai, Kahoolawe, and Molokai. The species will be recognized as *H. mannii* for the remainder of this review.

### **Historical Range**

Known historically from the Hawaiian Island of Kauai, but not observed since 1900.

### **Current Range**

Known currently from the Hawaiian Islands of Maui and Hawaii.

### **Critical Habitat Designated**

Yes; 5/14/2003.

### **Legal Description**

On March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Huperzia mannii*.

### **Critical Habitat Designation**

Maui—Lowland Mesic—Unit 1, Maui—Lowland Wet—Unit 1, Maui— Lowland Wet—Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet— Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui— Lowland Wet—Unit 7, Maui—Lowland Wet—Unit 8, Maui—Montane Wet— Unit 1, Maui—Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui— Montane Wet—Unit 4, Maui—Montane Wet—Unit 5, Maui—Montane Wet— Unit 6, Maui—Montane Wet—Unit 7, Maui—Montane Mesic—Unit 1, Maui— Montane Mesic—Unit 2, Maui— Montane Mesic—Unit 3, Maui— Montane Mesic—Unit 4, and Maui— Montane Mesic—Unit 5 constitute critical habitat for *Huperzia mannii* on Maui.

Maui—Lowland Mesic—Unit 1 consists of 1,147 ac (464 ha) of State land, 241 ac (97 ha) of privately owned land, and 494 ac (200 ha) of federally owned land (Haleakala National Park), from Manawainui Valley to Kukuiula on the eastern slopes of east Maui. This unit is occupied by the plants *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, and *Huperzia mannii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and

understory native plant species identified as physical or biological features in the lowland mesic ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Lowland Wet—Unit 1 consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *waihoiensis*, *Clermontia samuelii*, *Cyanea asplenifolia*, *C. copelandii* ssp. *haleakalaensis*, *C. duvalliorum*, *C. hamatiflora* ssp. *hamatiflora*, *C. kunthiana*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *M. ovalis*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Lowland Wet—Unit 2 consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has

determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Maui—Lowland Wet—Unit 6 consists of 136 ac (55 ha) of State land at Honokowai and Waihi valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformis*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Alectryon macrococcus*. These units also contain unoccupied habitat that is essential to the

conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyrifolium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Maui—Montane Wet—Unit 1 consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Cyanea duvalliorum*, *C. maritae*, *C. mceldowneyi*, *Huperzia mannii*, *Melicope balloui*, and *Phyllostegia pilosa*, and by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Montane Wet—Unit 3 consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *B. campylotheca* ssp. *waihoiensis*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. maritae*, and *Melicope ovalis*, and by the forest bird, kiwikiu (*Pseudonestor xanthophrys*). These

units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants *Adenophorus periens*, *Asplenium peruvianum* var. *insulare*, *Clermontia oblongifolia* ssp. *mauiensis*, *C. samuelii*, *Cyanea duvalliorum*, *C. glabra*, *C. horrida*, *C. kunthiana*, *C. mceldowneyi*, *Cyrtandra ferripilosa*, *Diplazium molokaiense*, *Geranium hanaense*, *G. multiflorum*, *Huperzia mannii*, *Melicope balloui*, *Peperomia subpetiolata*, *Phyllostegia bracteata*, *P. haliakalae*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Schiedea jacobii*, or *Wikstroemia villosa*, or by the forest bird, the akohekohe (*Palmeria dolei*), the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units are occupied by the plants *Clermontia samuelii*, *Cyanea copelandii* ssp. *haleakalaensis*, *C. hamatiflora* ssp. *hamatiflora*, *C. horrida*, *C. kunthiana*, *C. maritae*, *Cyrtandra ferripilosa*, and *Huperzia mannii*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

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

Maui—Montane Mesic—Unit 1 consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Argyroxiphium sandwicense* ssp. *macrocephalum*, *Asplenium dielirectum*, *A. peruvianum* var. *insulare*, *Clermontia lindseyana*, *Cyanea horrida*, *C. obtusa*, *Cyrtandra ferripilosa*, *C. oxybapha*, *Diplazium molokaiense*, *Geranium*

arboreum, *G. multiflorum*, *Huperzia mannii*, *Melicope adscendens*, and *Neraudia sericea*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Montane Mesic—Unit 2 consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuhunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Lysimachia lydgatei*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants *Geranium hillebrandii*, *Huperzia mannii*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem. They are occupied by the plants *Remya mauiensis* and *Santalum haleakalae* var. *lanaiense*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants *Ctenitis squamigera*, *Cyanea magnicalyx*, *Diplazium molokaiense*, *Geranium hillebrandii*, *Huperzia mannii*, *Lysimachia lydgatei*, *Stenogyne kauaulaensis*, or *Zanthoxylum hawaiiense*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

#### **Primary Constituent Elements/Physical or Biological Features**

(i) In unit Maui—Lowland Mesic— Unit 1, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: *Acacia*, *Diospyros*, *Metrosideros*, *Myrsine*, *Pouteria*, *Santalum*. (E) Subcanopy: *Dodonaea*, *Freycinetia*, *Leptecophylla*, *Melanthera*, *Osteomeles*, *Pleomele*, *Psydrax*. (F) Understory: *Carex*, *Dicranopteris*, *Diplazium*, *Elaphoglossum*, *Peperomia*.

(ii) In units Maui—Lowland Wet— Unit 1, Maui—Lowland Wet—Unit 2, Maui—Lowland Wet—Unit 3, Maui— Lowland Wet—Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet— Unit 6, Maui—Lowland Wet—Unit 7, and Maui—Lowland Wet—Unit 8, the physical and biological

features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

(iii) In units Maui—Montane Wet— Unit 1, Maui—Montane Wet—Unit 2, Maui—Montane Wet—Unit 3, Maui— Montane Wet—Unit 4, Maui—Montane Wet—Unit 5, Maui—Montane Wet— Unit 6, and Maui—Montane Wet—Unit 7, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

(iv) In units Maui—Montane Mesic— Unit 1, Maui—Montane Mesic—Unit 2, Maui—Montane Mesic—Unit 3, Maui— Montane Mesic—Unit 4, and Maui— Montane Mesic—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: 50 to 75 in (130 to 190 cm). (C) Substrate: Deep ash deposits, thin silty loams. (D) Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. (E) Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. (F) Understory: Ferns, Carex, Peperomia.

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of this species will continue to be degraded and destroyed.

### ***Life History***

### **Food/Nutrient Resources**

### **Habitat Type**

Adult: Terrestrial Forest - Hardwood, Forest/Woodland; Grows on trees in moist and wet forests.

### **Dependencies on Specific Environmental Elements**

Adult: Moist, wet forests

### **Environmental Specificity**

Adult: High

**Tolerance Ranges/Thresholds**

Adult: Low

**Dependency on Other Individuals or Species for Habitat**

Adult: Various native plant species on which it grows as an epiphyte.

**Habitat Narrative**

Adult: On East Maui, *Huperzia mannii* was observed growing as an epiphyte on aerial (above ground) roots of *Metrosideros polymorpha* (ohia) in *Acacia koa* (koa) – *Metrosideros polymorpha* – *Dicranopteris linearis* (uluhe) mesic forest with associated native species. At Lihau, West Maui, the habitat is *Metrosideros polymorpha* montane wet forest with associated native species.

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

Declined

**Species Trends:**

Declined

**Resiliency:**

Presumed low as a result of low population numbers and sizes.

**Representation:**

Low

**Redundancy:**

Low

**Population Growth Rate:**

Low

**Population Size:**

29 - 34 individuals

**Population Narrative:**

*Huperzia mannii* has not been seen on Kauai since 1900 (USFWS 2003c). In total, since 1991 the estimated census of *H. mannii* is reported at no more than 118 individuals in 9 populations only on Maui. Since 2003, only 61 to 71 individuals of *H. mannii* have been observed in 3 populations on Maui (USFWS 2010 5-year review). Currently (2014) only 29 to 31 individuals of *H. Mannii* have been observed on Maui.

***Threats and Stressors***

**Stressor:** Stochastic events

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Drought mortality and reduced viability threaten the taxon as a result of low population numbers and sizes.

**Stressor:** Climate change destruction or degradation of habitat

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that *H. mannii* is minimally vulnerable to the impacts of climate change.

**Stressor:** Habitat destruction, modification, curtailment by feral mammals and invasive plants.

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** On East Maui, threats include feral pigs (*Sus scrofa*), Axis deer (*Axis axis*), and goats (*Capra hircus*), which degrade the habitat (Perlman 2009; Wood 2009). Invasive introduced plants such as *Clidemia hirta* (Koster's curse), *Holcus lanatus* (common velvet grass), *Miconia calvenscens* (miconia), *Passiflora tarminiana* (banana poka), *Psidium cattleianum* (strawberry guava), *Rubus argutus* (blackberry), *Rubus rosifolius* (thimbleberry), and *Sphaeropteris cooperi* (Australian tree fern) degrade the habitat and invade openings created by disturbance, thus crowding out areas which might otherwise recruit and support native species like *Huperzia mannii* (Medeiros et al. 1996; Perlman 2009; USFWS 1997). Invasive introduced plants are also a threat on West Maui (Perlman 2009).

**Stressor:** Predation

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Rats (*Rattus* spp.), deer, goats, and slugs (unidentified species) are reported to consume the leaves and seeds of *Huperzia mannii* (Perlman 2009; Wood 2009).

**Stressor:** Competition

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Threats from invasive introduced plant species directly compete with *Huperzia mannii* for light, nutrients, and water.

### **Recovery**

**Reclassification Criteria:**

A total of 5 to 7 populations of the taxon should be documented on islands where they now occur or occurred historically.

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population.

Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered.

**Delisting Criteria:**

A total of 8 to 10 populations of the taxon should be documented on islands where they now occur or occurred historically.

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population for short-lived perennials.

Each population should persist at this level for a minimum of 5 consecutive years before delisting is considered.

***Conservation Measures and Best Management Practices:***

- Captive propagation for genetic storage and reintroduction
- Population viability monitoring and analysis
- Critical habitat designation of 23 units of unoccupied and occupied areas in the lowland mesic, lowland, wet, montane wet, montane mesic ecosystems on Maui.
- Surveys and inventories
- Reintroduction and translocation to augment current natural populations to increase numbers of individuals
- Ungulate monitoring and control by fencing remaining populations to protect them from the impacts of feral ungulates.
- Invasive plant control and monitoring within enclosures
- Predator and herbivore control (slugs and rodents) within the vicinity of all known populations of the taxon
- Population viability monitoring and analysis
- Alliance and partnership development to implement ecosystem-level restoration and management to benefit this taxon.

**References**

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USFWS. 2014. *Huperzia mannii* 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 8 pages

USFWS. 2011. *Huperzia mannii* 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 18 pages.

**SPECIES ACCOUNT: *Huperzia (=Phlegmariurus) nutans* (Wawae`iole)**

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***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 03/28/1994; Pacific Region (R1) (USFWS, 2016).

**Physical Description**

*Huperzia nutans* is a short-lived perennial member of the Lycopodiaceae (clubmoss family). This herbaceous epiphyte has a few tufted branches that can grow to greater than 50 cm (20 in) tall. Leaves are lance-shaped or linear, 10 to 15 mm (0.4 to 0.6 in) long, and 2 to 3 mm (0.1 in) wide. The reproductive cones are slender and range in length from 3 to 15 cm (1.2 to 5.9 in) and in width from 0.1 to 0.2 mm (0.0004 to 0.008 in). The sporophylls occur in four overlapping rows. *Huperzia nutans* can be distinguished from other Hawaiian species in the genus by its habit and large, stiff leaves (59 FR 14482).

**Historical Range**

Historically, *Huperzia nutans* was known from the islands of Kauai and Oahu. The specimen from Kauai has no specific habitat information associated with its collection. On Oahu, it was found in various locations in the Koolau Mountains of Oahu between Kaluanui Valley to the north, Paalaa to the west, and Mount Tantalus to the south (Service 1996).

**Current Range**

Currently, 11 individuals are found at five occurrences on the island of Oahu: north Kaukonahua Gulch (5 individuals), Kaukonahua Gulch (1), Kahana (2), Kaipapau (2), and Koloa Gulch (1) (K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). Occurrences and individuals of *P. nutans* are declining in the state of Hawaii. *Huperzia nutans* is considered to be extirpated from the island of Kauai. Occurrences on Oahu are small and widely dispersed (U.S. Army 2003a).

**Critical Habitat Designated**

Yes;

**Legal Description**

On September 18, 2012, the U.S. Fish and Wildlife Service designated critical habitat for *Huperzia nutans* (77 FR 57647 - 57862).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for *Huperzia nutans* (Wawaeiole) on the island of Kauai, Hawaii (68 FR 9116 - 9214).

**Critical Habitat Designation**

Oahu—Lowland Wet—Unit 6, Oahu— Lowland Wet—Unit 7, Oahu—Lowland Wet—Unit 8, Oahu—Lowland Wet— Unit 9, Oahu—Lowland Wet—Unit 10, Oahu—Lowland Wet—Unit 11, Oahu— Lowland Wet—Unit 12, Oahu— Lowland Wet—Unit 13, Oahu— Lowland Wet—Unit 14, Oahu— Lowland Wet—Unit 15, Oahu— Lowland Wet—Unit 16, Oahu—Wet Cliff—Unit 6, Oahu—Wet Cliff—Unit 7, and Oahu—Wet Cliff—Unit 8 constitute critical habitat for *Huperzia nutans* on Oahu.

Oahu—Lowland Wet—Unit 6 consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihihi, Wailele, and Koloa gulches. This area is occupied by the plant *Hesperomannia arborescens* and by the blackline and oceanic Hawaiian damselflies, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the blackline and oceanic Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *Lobelia oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or the crimson Hawaiian damselfly, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 7 consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). This unit is occupied by the plants *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. humboldtiana*, *C. purpurellifolia*, *C. truncata*, *Cyrtandra viridiflora*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Myrsine juddii*, *Phyllostegia hirsuta*, *Platydesma cornuta* var. *cornuta*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Tetraplasandra gymnocarpa*, *Viola oahuensis*, and *Zanthoxylum oahuense*, and by the blackline and oceanic Hawaiian damselflies. This area includes the wet forest and shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the blackline and oceanic Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. The streams, foraging areas, and cover areas that are occupied contain the essential PCEs, and the streams and upland areas that are not occupied are essential to the conservation of the species because they support the proper ecological functioning of the occupied areas within the ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Lowland Wet—Unit 8 consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēē, and Uwao streams. This area is occupied by the plant *Cyrtandra kaulantha*, and by the invertebrates, the blackline and crimson Hawaiian damselflies. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the blackline and crimson Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the oceanic Hawaiian damselfly, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 9 consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream, and is occupied by the plants *Chamaesyce rockii*, *Cyanea calycina*, *C. humboldtiana*, *C. koolauensis*, *C. st.-johnii*, *Cyrtandra viridiflora*, *Gardenia mannii*, *Hesperomannia arborescens*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platydesma cornuta* var. *cornuta*, *Pteris lidgatei*, *Tetraplasandra gymnocarpa*, *Viola oahuensis*, and *Zanthoxylum oahuense*, and by the blackline and crimson Hawaiian damselflies. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the blackline and crimson Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the

expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Cyanea acuminata*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. lanceolata*, *C. purpurellifolia*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. waiolani*, *Huperzia nutans*, *Isodendron longifolium*, *Lobelia gaudichaudii* ssp. *koolauensis*, *Myrsine juddii*, *Platanthera holochila*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Sanicula purpurea*, or *Trematolobelia singularis*, or by the oceanic Hawaiian damselfly, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 10 consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the blackline Hawaiian damselfly. Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 11 consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. This area is occupied by the blackline and oceanic Hawaiian damselflies, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the blackline and oceanic Hawaiian damselflies are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to these

damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson Hawaiian damselfly, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 12 consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for this Hawaiian damselfly. Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 13 consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. This area is occupied by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for this Hawaiian damselfly. Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 14 consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. This area is occupied by the plant, *Cyanea koolauensis*, and by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselfly. Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*,

*Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 15 consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. This area is occupied by the plant, *Cyanea crispa*, and by the blackline Hawaiian damselfly, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselfly. Because the streams and upland foraging and cover areas required by the blackline Hawaiian damselfly are dispersed in the lowland wet ecosystem, the lowland wet ecosystem's physical or biological features are essential to this damselfly species because they provide for the proper ecological functioning of this ecosystem. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea acuminata*, *C. calycina*, *C. grimesiana* ssp. *grimesiana*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra dentata*, *C. gracilis*, *C. kaulantha*, *C. polyantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Gardenia mannii*, *Hesperomannia arborescens*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Platydesma cornuta* var. *cornuta*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the crimson or oceanic Hawaiian damselflies, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Lowland Wet—Unit 16 consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamo Ridge. This area is occupied by the plants *Cyanea acuminata*, *C. calycina*, *C. crispa*, *C. humboldtiana*, *C. koolauensis*, *C. lanceolata*, *C. st.-johnii*, *Cyrtandra gracilis*, *C. polyantha*, *C. sessilis*, *Gardenia mannii*, *Hesperomannia aborescens*, *Platydesma cornuta* var. *cornuta*, *Sanicula purpurea*, and *Tetraplasandra gymnocarpa*. This area includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique PCEs for the Hawaiian damselfly. This area also contains unoccupied habitat that is

essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce rockii*, *Cyanea grimesiana* ssp. *grimesiana*, *C. purpurellifolia*, *C. truncata*, *Cyrtandra dentata*, *C. kaulantha*, *C. subumbellata*, *C. viridiflora*, *C. waiolani*, *Huperzia nutans*, *Isodendron longifolium*, *Labordia cyrtandrae*, *Lobelia gaudichaudii* ssp. *koolauensis*, *L. oahuensis*, *Melicope hiiakae*, *M. lydgatei*, *Myrsine juddii*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Platanthera holochila*, *Psychotria hexandra* ssp. *oahuensis*, *Pteralyxia macrocarpa*, *Pteris lidgatei*, *Trematolobelia singularis*, *Viola oahuensis*, or *Zanthoxylum oahuense*, or by the blackline, crimson or oceanic Hawaiian damselflies, the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 6 consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. This area includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem, and the unique features identified as PCEs for the Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the crimson and oceanic Hawaiian damselflies are dispersed in the wet cliff ecosystem, the wet cliff ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area is occupied by the plants *Cyanea crispa*, *Huperzia nutans*, *Pteralyxia macrocarpa*, and *Schiedea kaalae*, and by the oceanic Hawaiian damselfly. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Wet Cliff—Unit 7 consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem, and the unique features identified as PCEs for the crimson and oceanic Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the crimson and oceanic Hawaiian damselflies are dispersed in the wet cliff ecosystem, the wet cliff ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area is occupied by the plants *Cyanea crispa*, *Psychotria hexandra* ssp. *oahuensis*, and *Schiedea kaalae*, and by the crimson and oceanic Hawaiian damselflies. This area also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although this area is not currently occupied by the plants *Adenophorus periens*, *Chamaesyce deppeana*, *C. rockii*, *Cyanea acuminata*, *C. calycina*, *C. humboldtiana*, *C. purpurellifolia*, *C. st.-johnii*, *C. truncata*, *Cyrtandra kaulantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *Huperzia nutans*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Lysimachia filifolia*, *Phyllostegia hirsuta*, *P. parviflora*, *P. princeps*, *Pteralyxia macrocarpa*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, or *Viola oahuensis*, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the

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

Oahu—Wet Cliff—Unit 8 consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuana Pali State Wayside. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem, as well as unique for the species PCEs for the crimson and oceanic Hawaiian damselflies. Because the streams and upland foraging and cover areas required by the crimson and oceanic Hawaiian damselflies are dispersed in the wet cliff ecosystem, the wet cliff ecosystem's physical or biological features are essential to the damselfly species because they provide for the proper ecological functioning of this ecosystem. This area is occupied by the plants *Cyanea acuminata*, *C. calycina*, *C. humboldtiana*, *C. purpurellifolia*, *C. st.-johnii*, *Cyrtandra kaulantha*, *C. sessilis*, *C. subumbellata*, *C. viridiflora*, *Huperzia nutans*, *Labordia cyrtandrae*, *Lobelia oahuensis*, *Lysimachia filifolia*, *Phyllostegia hirsuta*, *P. parviflora*, *Plantago princeps*, *Pteralyxia macrocarpa*, *Sanicula purpurea*, *Tetraplasandra gymnocarpa*, *Trematolobelia singularis*, and *Viola oahuensis*. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Kauai 10—*Phlegmariurus nutans*—a This unit is critical habitat for *Phlegmariurus nutans* and is 621 ha (1,532 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains Kahili, Kalalea, Kamanu, Kapalaoa, and Kawaikini Summits. This unit provides habitat for three populations of 300 mature, reproducing individuals of the short-lived perennial *Phlegmariurus nutans* and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, tree trunks on open ridges and slopes in *Metrosideros polymorpha*-*Dicranopteris linearis* wet forest. This unit provides for three populations within this multiisland species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. This species has wind-blown spores with limited opportunity for germination and growth. Therefore, this species requires large intact areas of land to support a viable population.

#### **Primary Constituent Elements/Physical or Biological Features**

(i) In units Oahu—Lowland Wet—Unit 6, Oahu—Lowland Wet—Unit 7, Oahu—Lowland Wet—Unit 8, Oahu—Lowland Wet—Unit 9, Oahu—Lowland Wet—Unit 10, Oahu—Lowland Wet—Unit 11, Oahu—Lowland Wet—Unit 12, Oahu—Lowland Wet—Unit 13, Oahu—Lowland Wet—Unit 14, Oahu—Lowland Wet—Unit 15, and Oahu—Lowland Wet—Unit 16, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy:

Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

(ii) In units Oahu—Wet Cliff—Unit 6, Oahu—Wet Cliff—Unit 7, and Oahu—Wet Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Within the Kauai unit (Kauai 10), the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Tree trunks, usually on open ridges and slopes in Metrosideros polymorpha-Dicranopteris linearis wet or mesic forests and containing one or more of the following associated native plant species: Antidesma platyphyllum, Broussaisia arguta, Cheirodendron fauriei, Cibotium spp., Diplopterygium pinnatum, Hedyotis terminalis, Hibiscus kokio ssp. kokio, Melicope waialealae, Perrottetia sandwicensis, Psychotria hexandra, Psychotria mariniana, Psychotria wawrae, Scaevola gaudichaudii, or Syzygium sandwicensis; and

(ii) Elevations between 615 and 1,591 m (2,016 and 5,217 ft).

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of this species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas.

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

### ***Life History***

### **Food/Nutrient Resources**

### **Reproduction Narrative**

Adult: *Huperzia nutans* has been observed with spores in May. Additional information on reproductive cycles, dispersal agents, longevity, specific environmental requirements, or limiting factors is not available (Service 1998b).

**Habitat Type**

Adult: Open ridges and slopes

**Habitat Narrative**

Adult: *Huperzia nutans* grows on open ridges and slopes in *Metrosideros polymorpha*-dominated wet forests and, occasionally, mesic forests. It is known from elevations between 227 and 846 m (745 and 2,775 ft) with associated native plants that include *Antidesma platyphyllum*, *Broussaisia arguta*, *Cyrtandra laxiflora*, *Dicranopteris linearis*, *Elaphoglossum* sp., *Hedyotis terminalis*, *Hibiscus* spp., *Machaerina angustifolia*, *Psychotria mariniana*, *Syzygium sandwicensis*, and *Wikstroemia oahuensis* (HINHP Database 2001; Service 1998b).

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

Decreasing

**Population Size:**

11

**Population Narrative:**

Currently, 11 individuals are found at five occurrences on the island of Oahu: north Kaukonahua Gulch (5 individuals), Kaukonahua Gulch (1), Kahana (2), Kaipapau (2), and Koloa Gulch (1) (K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). Occurrences and individuals of *P. nutans* are declining in the state of Hawaii. *Huperzia nutans* is considered to be extirpated from the island of Kauai. Occurrences on Oahu are small and widely dispersed (U.S. Army 2003a).

***Threats and Stressors*****Stressor:****Exposure:****Response:****Consequence:**

**Narrative:** The primary threat to *Huperzia nutans* is habitat degradation by feral pigs and competition for light, space, and nutrients from non-native plant species such as *Clidemia hirta*, *Paspalum conjugatum*, *Psidium cattleianum*, and *Sacciolepis indica*. The small number of individuals and occurrences make *P. nutans* vulnerable to decreased reproductive vigor and extinction from stochastic events (HINHP Database 2001).

**Stressor:** Climate Change

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that *Huperzia nutans* is highly vulnerable to the impacts of climate change, with a score of 0.789 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future.

**Recovery****Recovery Actions:**

- *Huperzia nutans* is a short-lived fern ally. To meet the Preventing Extinction criteria, this species must be managed to control threats (e.g., fenced) and have 50 (or the total number per population if fewer than 50) individuals from each of three populations represented in an ex situ collection (at other than the plant's natural location, such as a nursery or arboretum). In addition, a minimum of three populations should be documented on the islands of Kauai or Oahu, where they now occur or occurred historically. Each of these populations should show signs of in situ reproduction (i.e. viable spores and sporelings), with a minimum of 50 mature individuals per population (USFWS, 2017).

**Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Huperzia nutans*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Exlosures should be constructed around the known occurrences of *P. nutans* to reduce impacts from feral pigs. Pigs should be controlled or removed from the greater landscape that is needed to sustain this clubmoss. Non-native plants should be controlled from the vicinity of *P. nutans*. Efforts should be made to establish this species ex situ for genetic storage (Service 1998b). On-going Conservation Actions  
Propagation of the species was attempted at the National Tropical Botanical Garden; however, these efforts were unsuccessful (Service 1998b). The Service is currently not aware of any other conservation efforts for this species.
- No significant new information regarding the species' biological status has come to light since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2017.
  - Surveys and inventories—Survey geographical and historic range for a thorough current assessment of the species, especially on Kauai, where currently considered extirpated.
  - Ungulate monitoring and control—Continue to construct exclosure fences to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates to prevent imminent extinction.
  - Invasive plant monitoring and control—
    - o Control established ecosystem-altering nonnative invasive plant species around all populations.
    - o Control invasive nonnative plant species around populations that compete with the species.
  - Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock.
  - Reintroduction and translocation—Reintroduce

individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human interaction monitoring and management— o Develop and implement effective measures to reduce the impacts of hikers and trail maintenance. o Develop and implement effective measures to reduce the impacts of military activities. Fire monitoring and control—Implement INRMP fire management plans for all wild and reintroduced populations on lands managed by the military. Develop and implement fire management plans for all other areas with wild and reintroduced populations. • Genetic research—Assess genetic variability within extant and ex situ populations. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals through historic range to reduce impacts of low viability. • Population biology research—Study *Huperzia nutans* populations to determine viable population size and structure, geographical distribution, reproductive cycles, longevity, specific environmental requirements, limiting factors, and threats. • Population biology research—Study the reproductive cycle and mycorrhizal (fungal) association for a better understanding of natural recruitment (USFWS, 2017).

## References

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Final Designation or Nondesignation of Critical Habitat for 95 Plant Species From the Islands of Kauai and Niihau, HI. Final rule. 68 FR 9116 - 9214 (February 27, 2003).

U.S. Fish and Wildlife Service. 2017. 5-YEAR REVIEW Short Form Summary Species Reviewed: *Huperzia nutans* (Wawae'iole). 8 pp.

## SPECIES ACCOUNT: *Huperzia (=Phlegmariurus) stemmermanniae* (Wawae`iole)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016b)

### **Physical Description**

*Huperzia stemmermanniae* is an epiphytic, pendant clubmoss found in mesic-to wet *Metrosideros polymorpha*-*Acacia koa* (ohia-koa) forests on the Hawaiian Islands of Maui and Hawaii. (USFWS, 2014)

### **Taxonomy**

First described as *Phlegmariurus stemmermanniae* by Medeiros and Wagner (Medeiros et al. 1996, pp. 90–96). Kartesz (1999, in NatureServe Explorer 2014, in litt.) moved the species to the genus *Huperzia*. Currently this species is recognized as a distinct taxon in the latest treatment (USFWS, 2015). (USFWS, 2014)

### **Historical Range**

On the islands of Hawaii and Maui. The Maui population has not been observed since 1995. (USFWS, 2014)

### **Current Range**

On the islands of Hawaii and Maui, although the Maui population has not been observed since 1995. (USFWS, 2014)

### **Critical Habitat Designated**

No;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: No information

### **Reproduction Narrative**

Adult: No information

### **Habitat Type**

Adult: Found in mesic-to wet *Metrosideros polymorpha*-*Acacia koa* (ohia-koa) forests

### **Geographic or Habitat Restraints or Barriers**

Adult: Found between 3,200 and 3,800 feet (USFWS, 2016)

### **Habitat Narrative**

Adult: *Huperzia stemmermanniae* is an epiphytic, pendant clubmoss found in mesic-to-wet *Metrosideros polymorpha*-*Acacia koa* (ohia-koa) forests on the Hawaiian Islands of Maui and Hawaii. This species is epiphytic on rough bark of living trees or fallen logs in *Metrosideros polymorpha*-*Acacia koa* forest on the island of Hawaii, from 3,200 to 3,800 ft (975 to 1,160 m), in the montane wet ecosystem (Medeiros et al. 1996b, p. 93; Palmer 2003, pp. 257, 259; TNCH 2007; HBMP 2010). (USFWS, 2014; USFWS, 2016)

***Dispersal/Migration*****Motility/Mobility**

Adult: Sessile

**Dispersal**

Adult: No information

**Dispersal/Migration Narrative**

Adult: Club moss; no information on dispersal

***Population Information and Trends*****Population Trends:**

Unknown

**Species Trends:**

Unknown

**Resiliency:**

Low

**Representation:**

Low

**Redundancy:**

Low

**Population Growth Rate:**

Unknown

**Number of Populations:**

3 known

**Population Size:**

20 individuals

**Minimum Viable Population Size:**

Unknown

**Resistance to Disease:**

Unknown

**Adaptability:**

Unknown

**Population Narrative:**

*Huperzia stemmermanniae* is an epiphytic, pendant clubmoss found in mesic-towet *Metrosideros polymorpha*-*Acacia koa* (ohia-koa) forests on the Hawaiian Islands of Maui and Hawaii. Only 3 populations are known, collectively totaling approximately 20 individuals. The Maui population has not been observed since 1995.

**Threats and Stressors**

**Stressor:** Feral pigs, goats, cattle, axis deer, nonnative plants (USFWS, 2014)

**Exposure:** Not assessed

**Response:** Not assessed

**Consequence:** Not assessed

**Narrative:** *Huperzia stemmermanniae* is threatened by feral pigs (*Sus scrofa*), goats (*Capra hircus*), cattle (*Bos taurus*), and axis deer (*Axis axis*) that degrade and destroy habitat. One individual at Waikamoi Preserve may benefit from fencing for axis deer and pigs. This species is represented in ex situ collections. The threats from pigs, goats, cattle, axis deer, and nonnative plants are imminent and of a high magnitude because they are sufficiently severe to adversely affect the species throughout its limited range, resulting in direct mortality or significantly reducing reproductive capacity and leading to a relatively high likelihood of extinction (USFWS, 2014).

**Stressor:** Nonnative plants (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Nonnative plants compete for light, space, and nutrients (USFWS, 2014). Nonnative plants, such as *Clidemia hirta*, *Miconia calvenscens*, *Psidium cattleianum*, and *Cyathea cooperi* (Australian tree fern), modify and destroy the forest habitat that supports the native species upon which this epiphytic plant grows, and drought also negatively affects this species and its habitat (Medeiros et al. 1996b, p. 96; Perry 2006, in litt.; HBMP 2010). (USFWS, 2016)

**Stressor:** Catastrophic events (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Huperzia stemmermanniae* is also threatened by randomly occurring natural events due to its small population size (USFWS, 2014).

**Stressor:** Reduced reproductive vigor (USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Huperzia stemmermanniae* experiences reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; HBMP 2010). (USFWS, 2016)

**Stressor:** Climate change (USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *H. stemmermanniae* is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions. Although the USFWS cannot predict the timing, extent, or magnitude of specific impacts, the USFWS do expect the effects of climate change to exacerbate the threats to *H. stemmermanniae* described above. (USFWS, 2016)

**Stressor:** Low numbers (USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The known individuals are restricted to a small area on Hawaii Island, and this species continues to be negatively affected by habitat modification and destruction by ungulates. The low numbers of individuals *H. stemmermanniae* reduces the probability of its long-term persistence. (USFWS, 2016)

### ***Recovery***

#### **Recovery Actions:**

- Captive propagation for genetic storage and reintroduction
- Reintroduction/translocation
- Ungulate monitoring/control
- Surveys/inventories
- Invasive plant monitoring/control
- Predator/herbivore control
- Population viability monitoring and analysis
- Alliance partnership development

#### ***Conservation Measures and Best Management Practices:***

- See Recovery Actions

### **References**

USFWS. 2014. Endangered and Threatened Wildlife and Plants

Review of Native Species That Are Candidates for Listing as Endangered or Threatened

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USFWS. 2016b. *Huperzia* (=Phlegmariurus) *stemmermanniae*. Environmental Conservation Online System (ECOS). <https://ecos.fws.gov/ecp0/profile>

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Endangered Status for 49 Species From the Hawaiian Islands, Final Rule. Federal Register Vol. 81, No. 190, p. 67786-67860.

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Annual Description of Progress on Listing Actions. Federal Register (79)(234) pp. 72450-72496.

## SPECIES ACCOUNT: *Hypolepis hawaiiensis* var. *mauiensis* (Olua)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

### **Physical Description**

*Hypolepis hawaiiensis* var. is an endemic Hawaiian fern with rhizomes and fronds (Palmer 2003, *mauiensis* pp. 168–170). It is a miniature variety of with fronds fully fertile when as small as 6 H. *hawaiiensis* centimeters long (Palmer 2003, pp. 168–170). (USFWS, 2014)

### **Taxonomy**

*Hypolepis hawaiiensis* var. (Hillebr.) D.D. Palmer is recognized as a distinct taxon by Palmer *mauiensis* (2003, pp. 168–170). (USFWS, 2014). *Hypolepis hawaiiensis* var. *mauiensis* (olua) is a small terrestrial member of the bracken fern family (Dennstaedtiaceae) (USFWS, 2016).

### **Historical Range**

This variety is historically known from west Maui (Palmer 2003, pp. 168–170) (USFWS, 2016).

### **Current Range**

Known from openings between bogs above 5,000 ft on west Maui, and a few individuals occur at Hanawi on east Maui" (USFWS 2015). (NatureServe, 2015)

### **Critical Habitat Designated**

No;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproduction Narrative**

Adult: Not available.

### **Habitat Type**

Adult: Terrestrial (USFWS, 2014)

### **Habitat Vegetation or Surface Water Classification**

Adult: Wet forest (USFWS, 2016)

### **Dependencies on Specific Environmental Elements**

Adult: Montane wet ecosystem (USFWS, 2016)

### **Habitat Narrative**

Adult: Known from openings between bogs above 5,000 ft on west Maui. *Hypolepis hawaiiensis* var. *mauiensis*, an understory fern, grows in mesic and wet forest (Palmer 2003, pp. 168–170). (USFWS, 2014; NatureServe, 2015) *Hypolepis hawaiiensis* var. *mauiensis* occurs in wet forest, predominately in the montane wet ecosystem (Palmer 2003, pp. 168–170; Oppenheimer 2015, in litt.).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available.

***Population Information and Trends*****Population Trends:**

Not available.

**Resiliency:**

Very low (inferred from NatureServe, 2015)

**Redundancy:**

Very low (inferred from NatureServe, 2015)

**Number of Populations:**

1 - 5 (NatureServe, 2015)

**Population Size:**

<20 plants (NatureServe, 2015)

**Population Narrative:**

Currently, 5 to 10 individuals are known from openings between bogs above 5,000 ft on west Maui, and a few individuals occur at Hanawi on east Maui" (USFWS 2015). Fewer than 20 individuals are known. (NatureServe, 2015)

***Threats and Stressors***

**Stressor:** Alien plants (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Nonnative plants displace native Hawaiian species by competing for water, nutrients, light and space; or they may produce a chemical that inhibits growth of other plants (Smith 1985, pp. 180-250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74). (USFWS, 2014)

**Stressor:** Climate change (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Climate change may pose a threat to the ecosystem that supports this species. Fortini et al. (2013, pp. 1-134) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013, p. 70) concluded that var. is moderately vulnerable to *Hypolepis hawaiiensis mauiensis* the impacts of

climate change. Therefore, additional management actions may be needed to conserve this taxon into the future. (USFWS, 2014)

**Stressor:** Foraging and trampling by feral ungulates (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Foraging and trampling of native plants by goats (*Capra hircus*), pigs (*Sus scrofa*), and axis deer (*Axis axis*) results in severe erosion of watersheds because these mammals inhabit terrain that is often steep and remote (Cuddihy and Stone 1990, p. 63). They destabilize soils that support native plant communities, bury or damage native plants, and adversely affect water quality due to runoff over exposed soils. They also destroy the seeds and seedlings of native plant species (Cuddihy and Stone 1990, p. 63), which facilitates the conversion of disturbed areas from native to nonnative vegetative communities. (USFWS, 2014)

**Stressor:** Soil disturbances by pigs (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Disturbance of soils by feral pigs creates fertile seedbeds for nonnative species (Cuddihy and Stone 1990, p. 65). (USFWS, 2014)

**Stressor:** Nutrient increases by pigs (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Nutrient availability increases as a result of pigs rooting in the nitrogen-poor soils, thus facilitating the establishment of nonnative invasive weeds. Invasive weeds are more adapted to nutrient rich soils than native plants (Cuddihy and Stone 1990, p. 63), and rooting activity creates open areas in forests allowing alien species to completely replace native stands. (USFWS, 2014)

**Stressor:** Predation/herbivory (USFWS, 2014; 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Rodents damage plant propagules, seedlings, or native trees, which changes forest composition and structure (Cuddihy and Stone 1990, p. 67). (USFWS, 2014) Herbivory by slugs is a threat (Oppenheimer 2015, in litt.) (USFWS, 2016).

**Stressor:** Predation by non-native insects (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Non-native insects feed on and defoliate native plants which reduces the geographic range of some species (Cuddihy and Stone 1990, p. 71). Nonnative insects also predate native insect pollinators, which can affect the reproductive success of native plant species (Cuddihy and Stone 1990, p. 71). (USFWS, 2014)

**Stressor:** Changes in nutrient cycling by non-native invertebrates (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Large numbers of non-native invertebrates such as earthworms, ants, slugs, isopods, millipedes, and snails can cause significant changes in nutrient cycling processes resulting in changes to the composition and structure of plant communities (Cuddihy and Stone 1990, p. 73). (USFWS, 2014)

**Stressor:** Isolation (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Species that are endemic to single islands or small island groups are inherently more vulnerable to extinction than are widespread species because of the increased risk of genetic bottlenecks, random demographic fluctuations, climate change effects, and localized catastrophes such as hurricanes, drought, rockfalls, landslides, and disease outbreaks (Pimm. 1988, p. 757; Mangel and Tier 1994, p. 607). (USFWS, 2014)

**Stressor:** Small population size (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** These problems are further magnified when populations are few and restricted to a very small geographic area, and when the number of individuals in each population is very small. Populations with these characteristics face an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (Gilpin and Soule 1986, pp. 2434). (USFWS, 2014)

**Stressor:** Reduced genetic diversity (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (e.g., Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361). (USFWS, 2014)

**Stressor:** Demographic fluctuations (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The problems associated with small population size and vulnerability to random demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats (e.g., nonnative plants and animals, drought, or fire). (USFWS, 2014)

**Stressor:**

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

### ***Recovery***

**Reclassification Criteria:**  
Not available.

**Delisting Criteria:**  
Not available.

**Recovery Actions:**

- Not available.

### ***Conservation Measures and Best Management Practices:***

- Survey for populations of *Hypolepis hawaiiensis* var. *mauiensis* in areas of potentially suitable habitat. (USFWS, 2014)
- Begin propagation efforts for maintenance of genetic stock. (USFWS, 2014)
- Reintroduce individuals into suitable habitat within historic range that is being managed for additional known threats (e.g., nonnative animals and plants) to this species. (USFWS, 2014)

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## SPECIES ACCOUNT: *Isoetes louisianensis* (Louisiana quillwort)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 10/28/1992; Southeast Region (R4) (USFWS, 2015)

### **Physical Description**

A semi-aquatic, primitive, seedless plant related to ferns. Produces numerous grass-like leaves that vary in length from 15 to 40 cm long depending on water depth. The leaves arise from a fleshy, 2-lobed stem that is shallowly rooted in the substrate. The plants produce spores in early spring and in the fall. (NatureServe, 2015)

### **Taxonomy**

This species represents a polyphyletic assemblage, meaning all the tetraploid populations identified as *I. louisianensis* do not represent the same biological entity (Heafner 2009). (NatureServe, 2015)

### **Historical Range**

Not Available

### **Current Range**

Occurs in ten counties in southern Mississippi, as well as St. Tammany and Washington Parishes in adjacent eastern Louisiana and Monroe and Conecuh Counties in nearby southern Alabama (Moore and Leonard 1996, Sorrie and Leonard 1999). Range extent is approximately 22,000 square km. (NatureServe, 2015)

### **Critical Habitat Designated**

Yes;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: Sexual (USFWS, 1996)

### **Breeding Season**

Adult: Winter to spring (inferred from EPA, 2016)

### **Key Resources Needed for Breeding**

Adult: Warm, wet conditions (USFWS, 1996)

### **Reproduction Narrative**

Adult: Fruiting is weather dependent and occurs from late spring through fall (EPA, 2016). Apparently, if conditions are warm and wet enough, sporangia develop and spores mature. After fertilization of the gametophyte, young sporophytes can emerge close to the parent sporophyte in a manner observed by Thieret (1980) and Taylor and Luebke (1986) and take root nearby or

be dispersed downstream. This process may explain the often dense growth patterns in quillwort population (USFWS, 1996).

**Habitat Type**

Adult: Aquatic, riparian (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Riverine, palustrine, riparian woodland, pine flatwoods (NatureServe, 2015)

**Dependencies on Specific Environmental Elements**

Adult: Flowing water (inferred from NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Linear (inferred from NatureServe, 2015), clumped (see reproduction narrative)

**Environmental Specificity**

Adult: Narrow (NatureServe, 2015)

**Site Fidelity**

Adult: High (see dispersal/migration narrative)

**Habitat Narrative**

Adult: Appears to be restricted to shallow blackwater streams in riparian woodland and bayhead forest areas of pine flatwoods. The plants are found on stable sand and gravel bars, moist overflow channels with silty sand substrates, and on low, sloping banks near and below water level. The environmental specificity is narrow, as it requires specific hydrology, water quality, and substrate characteristics in order to thrive. (NatureServe, 2015). It usually occurs under closed canopy. Typical colonies in south-central Mississippi occur in shallowly entrenched, intermittent streams lined with trees and some herbaceous cover. Also many tree roots bisecting the streams. Towards the coast of Mississippi and Louisiana, the habitat encompasses perennial streams with bald cypress. In Alabama, one colony occurs in a spring-like seepage with sandy muck soil and bald cypress that drains into a permanent creek. The other colony is along the margins of a grassy meadow and small hardwood swamp (EPA, 2016).

***Dispersal/Migration*****Dispersal**

Adult: Low (USFWS, 1996)

**Dispersal/Migration Narrative**

Adult: When Louisiana quillwort was first discovered, Thieret (1980) collected live plants with surrounding soil and cultivated them in a greenhouse at the University of Southwestern Louisiana. Plants were still thriving after 6 months. Thieret noted that “numerous young quillwort plants appeared in the soil of the pots. Many of these, while still only about 1 cm long and still attached to the megaspore, floated to the surface of the water.” He postulated that this phenomenon could be evidence, in natural conditions, for downstream dispersal of young plants. Taylor and Luebke (1986) experimented with spore germination and growing sporelings of aquatic species of Isoetes. They speculate (pers. comm. 1996) that the spiny surface

ornamentation of microspores (and to a lesser degree, megaspores) may lend itself to trapping, as spores become caught in the bases of the parent or nearby plants, or become embedded in soil nearby. In this manner, spores maintain close proximity to the colony despite sometimes swift water currents (USFWS, 1996).

### ***Population Information and Trends***

#### **Population Trends:**

Decline of 30-70% (NatureServe, 2015)

#### **Species Trends:**

Stable (USFWS, 2012)

#### **Resiliency:**

Moderate (inferred from USFWS, 2012)

#### **Representation:**

High (inferred from NatureServe, 2015)

#### **Redundancy:**

Moderate (inferred from USFWS, 2012)

#### **Number of Populations:**

20 (USFWS, 2012)

#### **Population Size:**

10,000 - 70,000 (NatureServe, 2015)

#### **Minimum Viable Population Size:**

Unknown (USFWS, 2012)

#### **Population Narrative:**

This species has experienced a long-term decline of 30-70%. The total population appears to be between 10,000 and 70,000 plants. Approximately 30 occurrences are believed to have excellent or good viability (NatureServe, 2015). The species status is stable, based on the 2011 Data Recovery Call. It is still unknown what the likely minimum number of populations is required to maintain genetic diversity and continued survival of Louisiana quillwort. Currently, there are 20 populations of Louisiana quillwort known from streams in 20 watersheds and 42 subwatersheds across southern portions of three states: Alabama, Louisiana, and Mississippi (USFWS, 2012).

### ***Threats and Stressors***

**Stressor:** Development (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Increased development in Washington and St. Tammany Parishes, Louisiana and coastal Mississippi counties continue to threaten Louisiana quillwort colonies in these areas (Leonard 2011, Smith in litt. 2011). Louisiana quillwort colonies in Louisiana and Mississippi are threatened by road construction and maintenance (such as widening and bridge replacement) (Leonard 2011, Smith in litt. 2011). Pipeline construction and maintenance may also threaten populations in these states (Leonard 2011) (USFWS, 2012).

**Stressor:** Habitat modification (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Habitat modification, such as overstory clearing, continues to threaten colonies in Louisiana and Mississippi (U.S. Fish and Wildlife Service 1996, Faulkner et al. 2009, Leonard 2011). The current threat of gravel mining to colonies in Louisiana is unknown. Off-road vehicle use and hay production threaten one colony in Alabama (Leonard 2011) (USFWS, 2012).

**Stressor:** Wildlife disturbance (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Disturbance by rooting armadillos (*Dasypus novemcinctus*) has been noted on Camp Shelby Joint Forces Training Center (CSJFTC). It is unclear whether armadillos are searching for and consuming Louisiana quillwort corms, but the impact of such foraging activities on Louisiana quillwort populations and habitat appears minimal (Lyman in litt. 2011c). Significant soil disturbance by feral hogs (*Sus scrofa*) has been documented on CSJFTC and the associated Leaf River Wildlife Management Area, Mississippi (Leonard 2011, Lyman in litt. 2011c). Although it is unlikely that feral hogs are foraging for Louisiana quillwort corms (Leonard 2011), extensive soil disturbance by foraging hogs within stream channels and their associated floodplains pose a significant threat to existing populations of Louisiana quillwort as well as to suitable habitat (Leonard 2011, Lyman in litt. 2011c). Beaver dams and their associated ponds may threaten some colonies of Louisiana quillwort in Louisiana and Mississippi (Leonard 2011, Lyman in litt. 2011b). Beaver dams downstream of two monitoring plots on CSJFTC caused water to become too deep and turbid to see or measure plants (USFWS, 2012).

**Stressor:** Climate change (USFWS, 2012)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Wind-throw from hurricanes has the potential to reduce scouring by directly increasing litter accumulation and blocking stream flow, thus allowing greater accumulation of sediment in impacted stream systems (Leonard 2011). If climate change reduces rainfall rates or increases the frequency of hurricanes making landfall on Alabama, Louisiana, or Mississippi, Louisiana quillwort would likely be adversely affected (USFWS, 2012).

## **Recovery**

### **Reclassification Criteria:**

Downlisting criteria were not identified in the recovery plan (USFWS, 2012).

**Delisting Criteria:**

10 viable and geographically distinct populations from distinctly separate drainages are protected. A viable population is one which is reproducing and stable or increasing in size as shown by monitoring for at least a 10-year period (USFWS, 2012).

**Recovery Actions:**

- Protect known populations by protecting their habitat (USFWS, 1996).
- Conduct life history research (USFWS, 1996).
- Monitor population trends and developing threats (USFWS, 1996).
- Search for additional populations in southeastern Louisiana, southern Mississippi, and south Alabama (USFWS, 1996).
- Preserve genetic stock (USFWS, 1996).
- Inform the public about the conservation needs of the species (USFWS, 1996).

**Conservation Measures and Best Management Practices:**

- Perform population status assessment updates (USFWS, 2012).
- Work with Federal and State entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations (USFWS, 2012).
- Implement aggressive feral hog (*Sus scrofa*) control programs (USFWS, 2012).
- Search for additional populations on private lands, particularly around De Soto National Forest in Mississippi (USFWS, 2012).
- Implement demographic and habitat studies to more fully understand underlying drivers of population fluctuations (USFWS, 2012).
- Continue and expand conservation genetics work to include all watersheds with known occurrences (USFWS, 2012).
- Preserve additional genetic stock (USFWS, 2012).
- Update the recovery plan (USFWS, 2012).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Perform population status assessment updates. • Work with Federal and State entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations. • Implement aggressive feral hog (*Sus scrofa*) control programs. • Search for additional populations on private lands, particularly around De Soto National Forest in Mississippi. • Implement demographic and habitat studies to more fully understand underlying drivers of population fluctuations. • Continue and expand conservation genetics work to include all watersheds with known occurrences. • Preserve additional genetic stock. • Update the recovery plan. RECOMMENDATIONS FOR FUTURE ACTION The previous 5-year review included a list of recommendations to improve recovery of the species.

Accomplishments toward these recommended actions are summarized below. A. Monitoring is inconsistent range-wide with only some populations in Mississippi receiving regular monitoring. B. Work with Federal partners to protect and manage the species has continued primarily under the Service's section 7 consultation provisions (e.g., USFS 2014). Annual meetings between multiple Federal and State agencies, Mississippi Army National Guard personnel and staff, and TNC at Camp Shelby Joint Forces Training Center provide regular opportunities to discuss and address conservation of Louisiana quillwort and other species. The Service's Louisiana Ecological Services Field Office's Partners Program has provided funding to support land conservation on private lands that benefits at least one Louisiana quillwort population in Louisiana. C. Wild hog control efforts are underway, but would benefit from additional funding and focus on areas where Louisiana quillwort

and wild hogs co-occur. D. Monitoring of and searches for Louisiana quillwort by TNC staff on Camp Shelby Joint Forces Training Center and by USFS staff on De Soto National Forest in Mississippi are ongoing. Likewise, periodic searches for the species occur throughout its range pursuant to section 7 consultation activities. However, limited efforts beyond section 7 related activities have been made to focus searches on private lands within the species' range since 2012. E. The Nature Conservancy in Mississippi has engaged in some demographic and habitat studies of Louisiana quillwort on Camp Shelby Joint Forces Training Center, but the study is ongoing and results have not been formally analyzed or evaluated and, therefore, insights from this work are currently limited. F. While some genetics work has been conducted since the last 5-year review, this work has primarily focused on the phylogenetics and species discrimination. G. No additional genetic material has been placed into ex situ safeguarding collections. To date, the single known ex situ safeguarding collection only contains material from Louisiana. H. The recovery plan still needs to be updated. In addition to the above accomplishments and remaining needs, the following activity is also recommended: I. A range-wide investigation of the species that includes morphological, habitat, and genetic studies is needed to resolve current and potential future discrepancies between field identifications and genetic identity of Louisiana quillwort records (USFWS, 2019).

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## SPECIES ACCOUNT: *Isoetes melanospora* (Black spored quillwort)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 2/5/1988; Southeast Region (Region 4) (USFWS, 2015)

### **Physical Description**

A perennial fern ally that forms small tufts of erect to spreading, linear leaves, 2.5-8 cm tall, usually arranged spirally on the bulbous rootstock. Produces dark-colored megaspores (most other quillworts have whitish spores), mostly in early May to June. (NatureServe, 2015)

### **Taxonomy**

Distinct species, distinguished by its complete velum coverage, dark tuberculate megaspores, and short spiral leaves. (NatureServe, 2015)

### **Historical Range**

Known (historically) from 1 site in S. Carolina. (NatureServe, 2015)

### **Current Range**

Piedmont physiographic region in Georgia. (NatureServe, 2015)

### **Critical Habitat Designated**

Yes;

### **Life History**

### **Food/Nutrient Resources**

### **Food/Nutrient Narrative**

Adult: Moisture breaks dormancy, no matter what time of year it is. Dormancy caused by dry conditions. Plants switch from dormant to growing throughout the summer (EPA, 2016).

### **Reproductive Strategy**

Adult: Sexual (USFWS, 1993))

### **Breeding Season**

Adult: May - June (EPA, 2016)

### **Reproduction Narrative**

Adult: Sporelings are usually found late winter or early spring. Spores produced erratically from May through June (EPA, 2016). When conditions are favorable for fertilization, a flap opens in the megaspore wall, exposing one or more funnel-like necks, through which the motile male gametes (spermatozoids) may enter and fertilize the single egg located at the base of each neck. Following fertilization, a single zygote develops into a sporophyte, enclosed within the megaspore wall. A single juvenile leaf and root are soon produced and after continued growth the old megaspore wall is shed. How rapidly plants reach sexual maturity under the extreme conditions of their habitat is unknown. In cultivation, they can reach maturity in at most a few years (USFWS, 1993).

**Habitat Type**

Adult: Terrestrial, aquatic (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Temporary pool, granite outcrops (NatureServe, 2015)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Shallow, flat-bottomed, temporary pools that form in depressions on granite outcrops. These depressions are less than 3 dm deep and usually contain at least 2 cm of soil. They may be dry during much of the summer. Associated with other rare and endangered granite outcrop endemics, including *Amphianthus pusillus* (poolsprite). The environmental specificity of this species is very narrow (NatureServe, 2015). They sometimes occur in quarry pools formed on flat-to-doming granitic (either granite or granite-gneiss) outcrops. Outcrops are bare rock with small islands of vegetation present. Water is normally present in pools from late autumn to mid-spring (EPA, 2016).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Declining (USFWS, 2008)

**Resiliency:**

Low (inferred from NatureServe, 2015)

**Representation:**

Low (inferred from NatureServe, 2015)

**Redundancy:**

Moderate (inferred from NatureServe, 2015)

**Number of Populations:**

12 (NatureServe, 2015)

**Population Size:**

> 10,000 (NatureServe, 2015)

**Adaptability:**

Low (inferred from USFWS, 2008)

**Population Narrative:**

In Georgia there are 12 extant occurrences in 6 counties. There are five populations with good viability/integrity. There is a single large population in excess of 10,000 individuals in Georgia at one of the Mt. Arabia sites; other populations tend to be 50 plants or fewer (NatureServe, 2015). The species status is declining, based on the 2007 Recovery Data call. This species is vulnerable due to limited potential habitat and specialized microhabitat requirements (USFWS, 2008).

**Threats and Stressors**

**Stressor:** Habitat destruction and modification (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Quarrying continues to be the primary threat destroying granite outcrops. Environmental conditions on the remaining outcrops are still being modified by cattle eutrophication, littering, trash dumping, fire building, vandalism, and off-road vehicles. Development within Atlanta has become a new threat resulting in substantial habitat destruction (USFWS, 2008).

**Stressor:** Environmental changes (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** As this species requires high light intensities (Lamer 1958), excessive tree growth is suspected to be a problem at a few sites, due to shading. A few pools appear to be moving toward a later stage of succession due to excessive soil accumulation. Abnormally low temperatures can also damage or kill populations (USFWS, 2008).

**Stressor:** Recreation (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Publicly owned sites are subjected to excess foot traffic, littering, or vandalism. Vehicular traffic is a serious problem at many sites (USFWS, 2008).

**Stressor:** Hybridization (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** At three outcrops, this species has seemingly been outcompeted by hybrids of *I. melanospora* and *I. piedmontana* (Matthews and Murdy 1969) (USFWS, 2008).

**Recovery**

**Reclassification Criteria:**

Reclassification of black-spored quillwort or mat-forming quillwort to threatened will be considered when the following conditions are met: 1. Ten (10) populations exhibit a stable or increasing trend, evidenced by natural recruitment. 2. All 10 populations occur on lands protected via a conservation mechanism (addressed listing Factor A and D). 3. All 10 populations consist of at least 2 pools each, the 2 pools for black-spored quillwort must be at least 6 m<sup>2</sup> (65 ft<sup>2</sup>) in size, and the 2 pools for mat-forming quillwort must be at least 5 m<sup>2</sup> (54 ft<sup>2</sup>) in size (addresses listing factor E) (USFWS, 2019).

**Delisting Criteria:**

The black-spored quillwort and mat-forming quillwort will be considered for delisting when: 1. Fifteen (15) populations exhibit a stable or increasing trend, evidenced by natural recruitment. 2. All 15 populations occur on lands protected via a conservation mechanism (addressed listing factor A and D). 3. All 15 populations consist of at least 2 pools each, the 2 pools for black-spored quillwort must be at least 6 m<sup>2</sup> (65 ft<sup>2</sup>) in size, and the 2 pools for mat-forming quillwort must be at least 5 m<sup>2</sup> (54 ft<sup>2</sup>) in size (addresses listing factor E) (USFWS, 2019).

**Recovery Actions:**

- Protect populations and habitat (USFWS, 1993).
- Preserve genetic stock from acutely threatened populations (USFWS, 1993).
- Monitor populations to determine trends and developing threats (USFWS, 1993).
- Search for additional populations (USFWS, 1993).
- Reestablish populations and augment extant populations at protected locations, if deemed necessary (USFWS, 1993).
- Use management techniques to maintain and/or enhance populations (USFWS, 1993).
- Educate the public about the value and fragility of these species and their habitat (USFWS, 1993).
- ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS Because of the extirpation of the amphianthus population at Rusty Rock (II.B.1.1.4. (page 16)), we strike this portion of the Recovery Actions. The amphianthus population is considered extirpated and has been since 1998. Since the last recovery plan, several efforts have been made to artificially create pools and augment populations of all three granite outcrop species. To Section II.B.5. "Reestablish populations and augment populations at protected locations, if deemed necessary" (page 20), we would like to add the following information about population augmentation. Through partnerships with state, non-government, and other sources, populations at Heggie's Rock, Greensboro South, Bradley Mountain, Arabia Mountain, and Stone Mountain have all been modified through pool creation and/or pool modification. Artificial deepening of existing pools or artificially created pools should target the minimum pool size identified in the recovery 7 criteria for the species. Pool creation should target areas at the highest elevation (top of the watershed) of the outcrop and minimize impacts to surrounding landscape. Because of the natural geology of the sites, site choice should also assess likelihood of exfoliation fissures beneath the surface. When intersected, these fissures result in the failure of the pool to hold water. Coordination with the Service in determining locations, size, depth, and source populations should occur (USFWS, 2019).

***Conservation Measures and Best Management Practices:***

- Future efforts to move plants need to develop a protocol and monitoring schedule prior to moving plants. Any protocol must consider how to limit the potential hybridization of black-spored quillwort with other *Isoetes* (USFWS, 2008).
- The effects of quarry dust should be investigated (USFWS, 2008).
- Conservation priorities need to be developed that protect and/or enhance this plant as well as other community associates of the granite outcrop. At outcrops with conservation potential, the land owners need to be contacted to seek conservation easements or fee simple acquisition. The Service and State Heritage programs should contact private landowners to request their cooperation in plant conservation.
- Status surveys need to be completed for this species in all three States (USFWS, 2008).

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## SPECIES ACCOUNT: *Isoetes tegetiformans* (Mat-forming quillwort)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 2/5/1988; Southeast Region (Region 4) (USFWS, 2015)

#### **Physical Description**

An aquatic perennial fern ally that forms mats of prostrate-arching rhizome-like structures on or near the soil surface. Arising from these are erect to spreading, linear leaves, 3-7 cm long, arranged in 2 rows along the "rhizome." Spores are dark-colored (unlike most other quillworts, which have whitish spores), and are produced mostly from early May to October. This unique species is considered to be the most distinctive quillwort in North America. (NatureServe, 2015)

#### **Taxonomy**

Not Available

#### **Historical Range**

Not available

#### **Current Range**

Only Greene and Columbia Counties, Georgia. Reports from North Carolina are in error (i.e. Federal Register list). Fairly intensive work in western Georgia, South Carolina and North Carolina has not revealed this species.

#### **Critical Habitat Designated**

Yes;

#### ***Life History***

#### **Food/Nutrient Resources**

#### **Food/Nutrient Narrative**

Adult: Moisture breaks dormancy, no matter what time of year it is. Dormancy caused by dry conditions. Plants switch from dormant to growing throughout the summer.

#### **Reproductive Strategy**

Adult: Sexual, clonal (USFWS, 1993)

#### **Breeding Season**

Adult: May - October (EPA, 2016)

#### **Reproduction Narrative**

Adult: Sporadic spore production occurs from May to October (EPA, 2016). This species exhibits sexual and clonal reproduction (USFWS, 1993).

#### **Habitat Type**

Adult: Aquatic, terrestrial (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Palustrine: temporary pool; terrestrial: bare rock/talus/scree, barrens (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Shallow, flat-bottomed, temporary pools that form in depressions on granite outcrops. These depressions are less than 3 cm deep and usually contain at least 2 cm of soil. They may be dry during much of the summer. It requires an exacting combination of weather factors to grow to maturity. It is a rhizomatous colony-forming species (NatureServe, 2015). Outcrops are bare rock with small islands of vegetation present. Water is normally present in pools from late autumn to mid-spring (EPA, 2016). This is a colony-forming species (Bridges 1986a) (USFWS, 2008).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Declining (USFWS, 2008)

**Resiliency:**

Very low (inferred from NatureServe, 2015)

**Representation:**

Low (USFWS, 2008)

**Redundancy:**

Low (inferred from NatureServe, 2015)

**Number of Populations:**

7 (NatureServe, 2015)

**Population Size:**

1000 - 2500 individuals (NatureServe, 2015)

**Adaptability:**

Low (USFWS, 2008)

**Population Narrative:**

Only 7 small populations are known to be surviving. It occurs only in 2 counties in GA (NatureServe, 2015). The species status is declining, based on the 2007 Recovery Data Call. It has limited genetic diversity and may have limited ability to adapt to environmental change (USFWS, 2008).

**Threats and Stressors**

**Stressor:** Habitat destruction and modification (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Quarrying continues to be the primary threat destroying granite outcrops. Environmental conditions on the remaining outcrops are still being modified by cattle eutrophication, littering, trash dumping, fire building, vandalism, and off-road vehicles. Development in Atlanta has become a new threat to this habitat (USFWS, 2008).

**Stressor:** Excessive tree growth (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** As this species requires high light intensities (Lamar 1958), excessive tree growth is suspected to be a problem at a few sites, due to shading (USFWS, 2008).

**Stressor:** Recreation (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Publicly owned sites are subjected to excess foot traffic, littering, or vandalism. Vehicular traffic is also a serious problem at many sites (USFWS, 2008).

**Stressor:** Hybridization (USFWS, 2008)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** New evidence shows *I. tegetiformans* may also suffer from hybridization (USFWS, 2008).

**Recovery****Reclassification Criteria:**

10 viable and geographically distinct populations (separate outcrops), each with at least two occupied pools, are protected from any foreseeable threats (USFWS, 1993).

Reclassification of black-spored quillwort or mat-forming quillwort to threatened will be considered when the following conditions are met: 1. Ten (10) populations exhibit a stable or

increasing trend, evidenced by natural recruitment. 2. All 10 populations occur on lands protected via a conservation mechanism (addressed listing Factor A and D). 3. All 10 populations consist of at least 2 pools each, the 2 pools for black-spored quillwort must be at least 6 m<sup>2</sup> (65 ft<sup>2</sup>) in size, and the 2 pools for mat-forming quillwort must be at least 5 m<sup>2</sup> (54 ft<sup>2</sup>) in size (addresses listing factor E) (USFWS, 2019).

**Delisting Criteria:**

The black-spored quillwort and mat-forming quillwort will be considered for delisting when: 1. Fifteen (15) populations exhibit a stable or increasing trend, evidenced by natural recruitment. 2. All 15 populations occur on lands protected via a conservation mechanism (addressed listing factor A and D). 3. All 15 populations consist of at least 2 pools each, the 2 pools for black-spored quillwort must be at least 6 m<sup>2</sup> (65 ft<sup>2</sup>) in size, and the 2 pools for mat-forming quillwort must be at least 5 m<sup>2</sup> (54 ft<sup>2</sup>) in size (addresses listing factor E) (USFWS, 2019).

**Recovery Actions:**

- Protect populations and habitat (USFWS, 1993).
- Preserve genetic stock from acutely threatened populations (USFWS, 1993).
- Monitor populations to determine trends and developing threats (USFWS, 1993).
- Search for additional populations (USFWS, 1993).
- Reestablish populations and augment extant populations at protected locations, if deemed necessary (USFWS, 1993).
- Use management techniques to maintain and/or enhance populations (USFWS, 1993).
- Educate the public about the value and fragility of these species and their habitat (USFWS, 1993).
- **ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS** Because of the extirpation of the amphianthus population at Rusty Rock (II.B.1.1.4. (page 16)), we strike this portion of the Recovery Actions. The amphianthus population is considered extirpated and has been since 1998. Since the last recovery plan, several efforts have been made to artificially create pools and augment populations of all three granite outcrop species. To Section II.B.5. "Reestablish populations and augment populations at protected locations, if deemed necessary" (page 20), we would like to add the following information about population augmentation. Through partnerships with state, non-government, and other sources, populations at Heggie's Rock, Greensboro South, Bradley Mountain, Arabia Mountain, and Stone Mountain have all been modified through pool creation and/or pool modification. Artificial deepening of existing pools or artificially created pools should target the minimum pool size identified in the recovery 7 criteria for the species. Pool creation should target areas at the highest elevation (top of the watershed) of the outcrop and minimize impacts to surrounding landscape. Because of the natural geology of the sites, site choice should also assess likelihood of exfoliation fissures beneath the surface. When intersected, these fissures result in the failure of the pool to hold water. Coordination with the Service in determining locations, size, depth, and source populations should occur (USFWS, 2019).

**Conservation Measures and Best Management Practices:**

- Any future efforts to move plants need to develop a protocol and monitoring schedule prior to moving plants. Any protocol must consider how to limit the potential hybridization of black-spored quillwort with other Isoetes (USFWS, 2008).
- The effects of quarry dust should be investigated (USFWS, 2008).

- Conservation priorities need to be developed that protect and/or enhance each of these listed plants as well as other community associates of the granite outcrop. At outcrops with conservation potential, the land owners need to be contacted to seek conservation easements or fee simple acquisition. The Service and State Heritage programs should contact private landowners to request their cooperation in plant conservation (USFWS, 2008).
- Status surveys need to be completed for these species in all three states (USFWS, 2008).

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## SPECIES ACCOUNT: *Marsilea villosa* (Ihi`ihi)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 06/22/1992; Pacific Region (R1) (USFWS, 2016)

#### **Physical Description**

An aquatic to semi-aquatic fern with fronds that resemble four-leaf clovers (NatureServe, 2015).

#### **Taxonomy**

A member of the marsilea family (Marsileaceae) (USFWS, 2016). The genus is found throughout warmer regions of world. Brueggmann believes the Hawaiian species is distinct from the N. American marsilea vestita (NatureServe, 2015).

#### **Historical Range**

It is known from Niihau, Oahu, and Molokai (Palmer 2003, pp. 180–182) (USFWS, 2016).

#### **Current Range**

Currently, there are approximately three populations of *Marsilea villosa* on Moloka'i and two wild populations and one introduced population (at Makapu'u) on O'ahu (USFWS, 2018).

#### **Critical Habitat Designated**

Yes; 6/17/2003.

#### **Legal Description**

On March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Marsilea villosa*. On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Marsilea villosa* (Ihi`ihi) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Marsilea villosa* (77 FR 57648-57862). The critical habitat designation includes 4 critical habitat units, which encompass approximately 127 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Marsilea villosa* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

#### **Critical Habitat Designation**

Molokai—Coastal—Unit 1, Molokai—Coastal—Unit 2, Molokai—Coastal—Unit 3, Molokai—Coastal—Unit 4, Molokai—Coastal—Unit 5, Molokai—Coastal—Unit 6, and Molokai—Coastal—Unit 7 constitute critical habitat for *Marsilea villosa* on Molokai.

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant *Marsilea villosa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem. This

unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant *Marsilea villosa* and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahiu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants *Pittosporum halophilum*, *Schenkia sebaeoides*, and *Tetramolopium rockii*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 3 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Peucedanum sandwicense*, or *Sesbania tomentosa*, the Service has determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Peucedanum sandwicense* and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 4 is not known to be occupied by *Bidens wiebkei*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, the Service has determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants *Brighamia rockii*, *Peucedanum sandwicense*, and *Pittosporum halophilum*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal

ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 5 is not known to be occupied by *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, the Service has determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants *Bidens wiebkii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, and *Ischaemum byrnone*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 6 is not known to be occupied by *Brighamia rockii*, *Hibiscus brackenridgei*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, the Service has determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuihipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem. Although Molokai—Coastal—Unit 7 is not known to be occupied by *Bidens wiebkii*, *Brighamia rockii*, *Canavalia molokaiensis*, *Hibiscus arnottianus* ssp. *immaculatus*, *H. brackenridgei*, *Ischaemum byrnone*, *Marsilea villosa*, *Peucedanum sandwicense*, *Pittosporum halophilum*, *Schenkia sebaeoides*, *Sesbania tomentosa*, or *Tetramolopium rockii*, the Service has determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Marsilea villosa* includes 4 critical habitat units, covering two ecosystem types, which encompass approximately 127 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 9, 11, 12; Oahu—Lowland Dry—Unit 7.

Oahu—Coastal—Unit 9 [80 ac (33 ha)]. This area consists of 80 ac (33 ha) of State land in the coastal ecosystem on the leeward side of Makapuu Point (Puuokipahulu). Oahu—Coastal—Unit 11 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) of privately owned land in the coastal

ecosystem, at Ihiihilauakea on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 12 [11 ac (5 ha)]. This area consists of 11 ac (5 ha) of City and County land in the coastal ecosystem, at Nonoula on Koko Head (Kaihuokapuaa).

Oahu—Lowland Dry—Unit 7 [15 ac (6 ha)]. This area consists of 15 ac (6 ha) of State land in the lowland dry ecosystem, in Leahi (Diamond Head) Crater within Diamond Head State Monument.

### **Primary Constituent Elements/Physical or Biological Features**

The physical and biological features of critical habitat are:

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

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Marsilea villosa* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Marsilea villosa* occurs within the Coastal and Lowland dry ecosystems in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

Oahu—Coastal—Units 9, 11, 12. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (F) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Oahu—Lowland Dry—Unit 7. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative

ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Marsilea villosa* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

### ***Life History***

#### **Food/Nutrient Resources**

#### **Reproductive Strategy**

Adult: Sexual (USFWS, 2011); vegetative (USFWS, 1996)

#### **Key Resources Needed for Breeding**

Adult: Flooding/standing water followed by drying (USFWS, 2011); open canopy and soil surface (USFWS, 1996)

#### **Reproduction Narrative**

Adult: This species has an unusual reproductive cycle, in which the reproductive spores are found in hard sided sporocarps that protect the spores during dry periods, and release them after a flooding event has occurred. Because *Marsilea villosa* has a clumping growth habit, spreads by rhizomes, dies back when dry, resurrects itself in moist conditions from dormant rhizomes, and reproduces sexually only in flooding conditions, it is difficult to estimate the number of individuals in a clump or population (USFWS 1996). Standing water is required for sexual reproduction, and drying is required for new plant establishment and for sporocarp maturation (USFWS, 2011). Reproduction may occur as infrequently as once every ten or more years. due to the infrequency of sufficiently heavy rains in the lowland areas of Hawai'i where *M. villosa* occurs. The majority of the reproduction of *Marsilea villosa* occurs vegetatively, and rhizomes will fill all available soil surface if there is no shading or direct competition from other plants (Brueggemann 1986) (USFWS, 1996).

#### **Habitat Type**

Adult: Terrestrial, seasonal wetland (NatureServe, 2015)

#### **Habitat Vegetation or Surface Water Classification**

Adult: Coastal ecosystem (USFWS, 2016)

#### **Dependencies on Specific Environmental Elements**

Adult: Open canopy (USFWS, 2011); periodic flooding (NatureServe, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: Occurs < 500 ft. elevation (USFWS, 1996)

**Spatial Arrangements of the Population**

Adult: Clumped (USFWS, 2011; see reproduction narrative)

**Environmental Specificity**

Adult: Narrow (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Inhabits dry regions and shallow depressions temporarily flooded during the wet winter season. The soils are silty clay or lithified sand with a shallow clay top soil. An impervious layer prevents percolation and allows water to pond temporarily in the depressions (NatureServe, 2015). Shading by canopy trees has been noted to reduce its vigor (USFWS 1996; 2011). All reported populations occur at or below 500 feet (150 meters) elevation (USFWS, 1996). All occurrences are in the coastal ecosystem (USFWS, 2016).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: The method of dispersal of *Marsilea villosa* sporocarps is unknown. Pacific plovers (*Pluvialis dominica*) have been observed visiting the *M. villosa* population at Koko Head (Brueggemann 1988) (USFWS, 1996).

***Population Information and Trends*****Population Trends:**

Not available

**Resiliency:**

Very low (inferred from USFWS, 2016)

**Redundancy:**

Low (inferred from USFWS, 2016)

**Number of Populations:**

8 (USFWS, 2016)

**Population Size:**

Possibly thousands (USFWS, 2016)

**Population Narrative:**

Currently, *M. villosa* is known from eight occurrences on Molokai, totaling possibly thousands of individuals covering areas from 20 square (sq.) ft. (6 sq. m) to over 2 ac (0.8 ha), all in the coastal ecosystem (Perlman 2006b, in litt.; TNC 2007; Bakutis 2009b, in litt.; Wood 2009m, in litt.; Chau 2010, in litt.; Garnett 2010b in litt.; HBMP 2010; Oppenheimer 2010u, in litt.) (USFWS, 2016).

***Threats and Stressors***

**Stressor:** Invasive plants and altered hydrology (USFWS, 2011; NatureServe, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Shading and competition for water by naturalized, exotic plants are the two greatest threats (NatureServe, 2015). Ecological changes may have altered the rate at which the soil dries, which affects the frequency of flooding events essential to *M. villosa* reproduction. With the decline of *P. pallida*, perennial grasses such as *Urochloa maximum* (guinea grass) and *Cenchrus ciliaris* (buffelgrass) began to replace the open space in the bottom of the crater. These two grasses are speculated to increase water loss by transpiration, while the deep-rooted canopy tree species *P. pallida* is more likely to be drawing on different sources of moisture than the shallow-rooted grasses. An increased rate of water loss by transpiration causes the soil to dry faster, reduce soil moisture content, and increase the soil's capacity to absorb extreme rainfall events. As a result, soil surface accumulation and flooding events would decline, which are essential in preventing the establishment of invasive grasses and for spores of *M. villosa* to germinate (USFWS, 2011).

**Stressor:** Small population size (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Not available

**Stressor:** Fire (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Fire presents a potential threat to all populations, especially during dry periods, when most of the biomass is dead and easily flammable (USFWS, 1996).

**Stressor:** Ungulates (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Cattle previously ranged freely through the Ma'ili'ili'i subpopulation at Lualualei. Although they did not appear to feed on the species, trampling may have caused permanent damage. Axis deer at the Kamaka'ipo site are believed to browse and trample the species, which may cause permanent damage to individual plants and decrease the species' ability to compete with alien plant species (USFWS, 1996).

**Stressor:** Recreation (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** At Koko Head and Makapuu on Oahu, off-road vehicles and increased foot traffic from recreational hiking are impacts to *Marsilea villosa* because the plants often occurs where water pools in depressions created by the tires of vehicles (USFWS, 2011).

**Stressor:** Climate change (USFWS, 2011)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Climate change may also pose a threat to this species, however current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2011).

**Stressor:** Collection (USFWS, 1996)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Being sold by the nursery trade is also a threat to *Marsilea villosa*. Other species of *Marsilea* from Asia are currently in the nursery trade in Hawai'i and because *M. villosa* is an attractive plant, it may be of interest to researchers, curiosity seekers, or collectors of rare or aquatic plants (USFWS, 1996).

### ***Recovery***

#### **Reclassification Criteria:**

Six geographically distinct, self-sustaining populations (three on O'ahu and three on Moloka'i or three on O'ahu, two on Moloka'i, and one on Ni'ihau) are adequately protected and have been maintained through two successive floods resulting in sexual reproduction (USFWS, 1996).

#### **Delisting Criteria:**

Active management is no longer needed to maintain the downlisting criteria for six populations (USFWS, 1996).

#### **Recovery Actions:**

- Protect and manage current populations (USFWS, 1996).
- Conduct research on potential management techniques and limiting factors (USFWS, 1996).
- Reintroduce in former range as needed to meet downlisting criteria (USFWS, 1996).
- Augment current populations (USFWS, 1996).
- Study ecology of the species (USFWS, 1996).
- Validate recovery objectives (USFWS, 1996).

#### ***Conservation Measures and Best Management Practices:***

- Collect sporocarps for genetic storage (USFWS, 2011).
- Collect sporocarps and plants for propagation for reintroduction (USFWS, 2011).
- Work with Hawaii Division of Forestry and Wildlife, Hawaii State Parks, U.S. Navy, The Nature Conservancy Hawaii, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Continue to monitor current populations through seasonal fluctuations, year after year (USFWS, 2011).
- Research best management practices, including the use of mowing to reduce competition from taller-growing grasses (USFWS, 2011).

- Conduct genetic analyses to determine best strategies for reintroduction and augmentation of populations, and to determine whether populations are reproducing sexually as well as vegetatively (USFWS, 2011).
- Reintroduce new populations in appropriate habitat within its former range to augment genetic representation in each site (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).
- Research long-term viability of *Marsilea villosa* spores to determine if they are as long-lived as those of some other *Marsilea* species (USFWS, 2011).
- Develop and implement wildfire management plans for each population (USFWS, 2011).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018.
  - Population viability and monitoring—Continue to monitor known localities and suitable habitat areas on Moloka'i and O'ahu through seasonal fluctuations.
  - Ungulate monitoring and control—Construct and maintain exclusion fences to protect *Marsilea villosa* from the impacts of feral ungulates on O'ahu and Moloka'i.
  - Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations.
  - Captive propagation for genetic storage and reintroduction—
    - o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range.
    - o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change.
    - o Research long-term viability of *M. villosa* spores.
    - o Continue to research population biology to determine the best strategies for reintroduction and assurance of sexual reproduction as well as clonal growth.
  - Reintroduction and translocation—
    - o Augment current populations and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species.
    - o Research best management practices including the use of mowing to reduce competition by invasive grasses.
  - Fire destruction or degradation of habitat—Develop and implement fire prevention and management plans for O'ahu and Moloka'i.
  - Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future.
  - Alliance and partnership development—Work with the Hawai'i Division of Forestry and Wildlife, the U.S. Navy, The Nature Conservancy, Moloka'i Land Trust, and other land managers to initiate planning and contribute to the implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2018).

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U.S. Fish and Wildlife Service. 2018. 5-YEAR REVIEW. Short Form Summary. Species Reviewed: *Marsilea villosa* ('ihi'ih). 10 pp.

## SPECIES ACCOUNT: *Microlepia strigosa* var. *mauiensis* (Maui fern)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2017)

### **Physical Description**

*Microlepia strigosa* var. *mauiensis* ferns are terrestrial, medium-sized, with fronds less than 40 inches (in) (100 centimeters (cm)) long. This taxon is an extremely hairy variety of *M. strigosa*, with the stipes, rachises, costae, and entire fronds covered with uniform, jointed hairs with pointed tips. The rachises are often zigzag (Palmer 2003, p. 186).

### **Taxonomy**

This taxon was originally described as *Microlepia mauiensis* by Wagner (1993), from a collection made at Hanaula, west Maui. In the most recent treatment of all Hawaiian ferns, Palmer (2003, p. 186) recognizes this entity as an endemic variety of the indigenous *Microlepia strigosa*. Lau expressed some doubt that this entity represents a continuum of *Microlepia strigosa*, as it may be a distinct species (*Microlepia mauiensis*) (Lau 2007, pers. comm.). According to Lau, further taxonomic study is needed, as well as additional surveys statewide in suitable habitat (Lau 2007, pers. comm.). in the bracken fern family (Dennstaedtiaceae) (Palmer 2003, p. 186) (USFWS, 2016).

### **Historical Range**

Little is known of the historical locations of *Microlepia strigosa* var. *mauiensis*. The type was collected at Hanaula in the west Maui Mountains (Wagner 1993).

### **Current Range**

U.S.: Hawaii: Maui, Maui County; Hawaii, Hawaii County; Oahu, Honolulu County. Currently, *Microlepia strigosa* var. *mauiensis* is found in the Waiakea and Hilo Watershed FRs, on the island of Hawaii; at Pohakea and Poelua gulches on west Maui, and at Hanaula, in The Nature Conservancy's Waikamoi Preserve, and at Manawainui in Haleakala National Park on east Maui; and at Makaleha and Makaha Valley in the Waianae Mountains on Oahu (Lau 2007, pers. comm.; Oppenheimer, in litt. 2007; HBMP 2008; Oppenheimer, in litt. 2008; Welton, in litt. 2008).

### **Critical Habitat Designated**

No;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: No information

### **Reproduction Narrative**

Adult: No information

**Habitat Type**

Adult: Mesic to wet forest at elevations between 1,394 and 6,004 feet (ft) (425 and 1,830 meters (m)) (Palmer 2003, p. 186; Hawaii Biodiversity and Mapping Program (HBMP) 2008).

**Dependencies on Specific Environmental Elements**

Adult: Lowland mesic, montane mesic, and montane wet ecosystems (USFWS, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: between 1,394 and 6,004 ft. elevation

**Habitat Narrative**

Adult: Typical habitat is mesic to wet forest at elevations between 1,394 and 6,004 feet (ft) (425 and 1,830 meters (m)) (Palmer 2003, p. 186; Hawaii Biodiversity and Mapping Program (HBMP) 2008). It occurs in the lowland mesic (Oahu), montane mesic (Hawaii Island), and montane wet (Maui and Hawaii Island) ecosystems (Palmer 2003, p. 186; TNCH 2007: HBMP 2010) (USFWS, 2016).

***Dispersal/Migration*****Motility/Mobility**

Adult: Sessile plant

**Dispersal**

Adult: No information

**Dependency on Other Individuals or Species for Dispersal**

Adult: No information

**Dispersal/Migration Narrative**

Adult: Plant; no other information

***Population Information and Trends*****Population Trends:**

Not assessed

**Species Trends:**

Not assessed

**Resiliency:**

Low

**Representation:**

low

**Redundancy:**

low

**Population Growth Rate:**

Unknown

**Number of Populations:**

Nine

**Population Size:**

Oahu: 40; Maui: &lt; 20; Hawaii: 35 (USFWS, 2016)

**Minimum Viable Population Size:**

Unknown

**Resistance to Disease:**

Unknown

**Adaptability:**

Unknown

**Population Narrative:**

*Microlepidia strigosa* var. *mauiensis* is known from nine populations totaling at least 50 to more than 100 individuals on Maui, Hawaii, and Oahu observed during surveys conducted as recently as 2007 (Palmer 2003, p. 186; Lau 2007, pers. comm.; Oppenheimer, in litt. 2007 and 2008; Welton, in litt. 2008). We are unaware of additional surveys conducted to date (6-14). The island of Hawaii populations are at Saddle Road (15 individuals) and Puu Oo trail (20 individuals) (HBMP 2008). Populations on west Maui occur at Poelua (numbers unknown), and Pohakea and Hanaula Gulches (at both sites, more than 100 total observed in 1984), and on east Maui in the Waikamoi Preserve (not uncommon) and at Manawainui (fewer than 20 individuals) (Lau 2007, pers. comm.; Oppenheimer, in litt. 2007 and 2008; Welton, in litt. 2008; Bily, in litt. 2009; Welton, in litt. 2010). Hybrid and non-hybrid populations on Oahu occur at Makaleha (a patch of individuals) and Makaha Valley (1 individual), with 15-20 individuals of which many are hybrids at west Makaleha (Lau 2007, pers. comm.; Kawelo, in litt. 2010; Ching, in litt. 2011; Perlman, in litt. 2011). Botanists suggest this variety may be more widespread and could be found in more areas if surveys were conducted (Lau 2007, pers. comm.; Kawelo, in litt. 2010; Hadway, in litt. 2013). According to the Plant Extinction Prevention Program (PEPP) (in litt. 2012), non-hybrid individuals of this species are now only represented in the wild on Oahu by 15 to 20 plants located at the Makaleha population site. Current totals are fewer than 100 individuals on the islands of Oahu (about 40 individuals), Maui (fewer than 20 individuals on east and west Maui), and Hawaii (35 individuals last observed in 2004) (Palmer 2003, p. 186; Lau 2007, pers. comm.; Oppenheimer 2007 and 2008, in litt.; Welton 2008, in litt.; Ching 2011, in litt.; Ching Harbin 2015, in litt.; Oppenheimer 2015, in litt.) (USFWS, 2016).

**Threats and Stressors****Stressor:** Habitat degradation and loss by feral pigs**Exposure:****Response:****Consequence:**

**Narrative:** Rooting by feral pigs was observed to be related to the search for earthworms, with rooting depths averaging 8 in (20 cm) greatly disrupting the leaf litter and topsoil layers and contributing to erosion and changes in ground topography. The feeding habits of pigs created seed beds, enabling the establishment and spread of weedy species such as *Psidium cattleianum* (strawberry guava). The study concluded that all aspects of the food habits of pigs are damaging to the structure and function of the Hawaiian forest ecosystem (Diong 1982, pp. 164-165).

**Stressor:** Habitat degradation and loss by nonnative plants

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The original native flora of Hawaii consisted of about 1,400 species, nearly 90 percent of which were endemic. Of the current total native and naturalized Hawaiian flora of 1,817 taxa, 47 percent were introduced from other parts of the world, and nearly 100 species have become pests (Smith 1985, p. 180; Wagner et al. 1999a, p. 45). Several studies (Cuddihy and Stone 1990, p. 74; Robichaux et al. 1998, p. 4) indicate nonnative plant species may outcompete native plants similar to *Microlepia strigosa* var. *mauiensis*. Competition may be for space, light, water, or nutrients, or there may be a chemical produced that inhibits growth of other plants (Smith 1985, pp. 227-230; Cuddihy and Stone 1990, p. 74). In addition, nonnative pest plants found in habitat similar to that of this species have been shown to make the habitat less suitable for native species (Smith 1985, pp. 240-241; Loope and Medeiros 1992, pp. 7-8; Medeiros et al. 1992, p. 30; Ellshoff et al. 1995, pp. ii, 3-4; Meyer and Florence 1996, p. 778; Medeiros et al. 1997, pp. 23-24; Loope et al. 2004, p. 1,472). In particular, alien pest plant species degrade habitat by modifying availability of light, altering soil-water regimes, modifying nutrient cycling, or altering fire characteristics of native plant communities (Smith 1985, pp. 227-230; Cuddihy and Stone 1990, p. 74; Vitousek et al. 1997, pp. 6-10). Because of demonstrated habitat modification and resource competition by nonnative plant species in habitat similar to mesic to wet forest habitat of *M. strigosa* var. *mauiensis*, the FWS believes nonnative plant species are a threat to *M. strigosa* var. *mauiensis*.

**Stressor:** Hybridization (USFWS, 2016)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Hybridization with other species and varieties of *Microlepia* is a threat to this plant on Oahu and is compounded by the low number of individuals (Kawelo 2010, in litt.) (USFWS, 2016).

## **Recovery**

### **Recovery Actions:**

- Conduct taxonomic review to determine if *Microlepia strigosa* var. *mauiensis* is a variety or a distinct species.
- Survey for populations of *M. strigosa* var. *mauiensis* in areas of potentially suitable habitat.
- Control feral pigs by removing these species from areas where populations of this species exist and preventing reinvasion through the use of exclosures.
- Determine specific nonnative plant threats to populations in east Maui, Oahu, and Hawaii Island.

- Control alien plants through physical, mechanical, and biological control methods, as well as herbicides when necessary. Continue to conduct research into potential biocontrol species.
- Begin propagation efforts for maintenance of genetic stock.
- Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species.

***Conservation Measures and Best Management Practices:***

- (Feral) Pig removal and control
- Nonnative plant removal and control
- Fence construction and maintenance to keep out feral pigs and livestock
- Monitoring

***Additional Threshold Information:***

- 
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**References**

USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for *Microlepidia strigosa* var. *mauiensis* (Maui Fern), Pacific Region (Region 1), 6/19/2014, 14 p.

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## SPECIES ACCOUNT: *Polystichum aleuticum* (Aleutian shield fern)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 02/17/1988; Alaska Region (R7) (USFWS, 2016)

### **Physical Description**

A small, tufted fern, that sends out fronds (about 15 cm high) from a thick, chestnut brown rhizome. This Alaska endemic is apparently a Tertiary relict with no closely related taxa in the western hemisphere. It is closely related to *P. lachenense* of Asia. (NatureServe, 2015)

### **Taxonomy**

*P. aleuticum* is a well-marked and extremely narrow endemic which is not closely related to any other species in North America. Its only close affinities are with taxa of Himalayan-Sino-Taiwan-Japan distribution. Although its taxonomic relationship to other species has not been determined, *P. aleuticum* appears most closely related to *P. lachenense*, a species distributed from the Himalaya eastward on several high mountains of central China, Taiwan, and northern Japan (Smith and Davison 1988) (USFWS, 1992).

### **Current Range**

Very narrow endemic, now known from only 3 rock outcrops on Mt. Reed, Adak I. Historically also known from Atka I. Nearest location of a closely related taxon is Honshu, Japan.

### **Critical Habitat Designated**

Yes;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: Cloning appears to be the main reproductive strategy (NatureServe, 2015)

### **Reproduction Narrative**

Adult: Typical of all "true ferns" with haploid (1N) and diploid (2N) phases. Sexual reproduction depends on the ability to complete both phases. All stages of life cycle have not been observed in nature. Species regularly produces spores that show no evidence of abnormal development. Diasporic or apogamous mechanisms have not been observed in this species. Strongly rhizomatous habit, and the general reduction in sexual reproduction for most taxa in the Aleutian Islands, suggests vegetative propagation by cloning may be the principal means of spread. Lack of specialized asexual mechanisms supported by small number of individuals and spotty distribution. Although spores are produced annually, successful sowing and germination have not been observed. Spring and fall germination unknown. Annual production of leaves most likely occurs after habitat becomes snow free during Aleutian spring. Mature spores have been observed on Atka, collections dated 5 July 1932; field observations of mature spores 6 July 1989 for Adak, collections dated 19 Sept. 1985, 29-31 Aug. 1989. (There may be considerable variation in date of maturation of spores depending on specific site characteristics of individual plants- snow accumulation, insolation, etc., and phenology of specific years. Smith (Smith, 1988)

reported that plants observed on Adak 17 Aug. 1987 had only "unripened, immature spores".) Mature spores readily released during season of production. Virtually nothing known about spore biology. Germination tests under controlled conditions begun in Oct. 1989; spores from 5-6 individuals developed to prothallium within 2 months; sporophyte produced within 6 months. Most species in genus produce bisexual haploid phase, often with in-crossing barriers that inhibit or prevent self-fertilization. Small, highly restricted gene pool of *P. aleuticum* coupled with an out-crossing requirement may account for low number of populations and individuals. Reproductive, survival, and mortality rates unknown; permanent population monitoring plots established in 1989. (Lipkin, 1985; Smith, 1988; Tande, 1989); Self-dispersing; Wind; ABIOTIC; Water; Wind (NatureServe, 2015).

**Habitat Type**

Adult: Cliffs/rock outcrops (NatureServe, 2015)

**Spatial Arrangements of the Population**

Adult: Clumped (NatureServe, 2015)

**Environmental Specificity**

Adult: Narrow/specialist (NatureServe, 2015)

**Tolerance Ranges/Thresholds**

Adult: Low (inferred from NatureServe, 2015)

**Site Fidelity**

Adult: High (inferred from NatureServe, 2015)

**Habitat Narrative**

Adult: Species inhabits cliffs and rock outcrops on east-facing volcanic slopes at 365 to 525 m elevation. Found in protected gullies and grottos and on ledges, commonly associated with roundleaf willow (*Salix rotundifolia*), Alaska large awn sedge (*Carex macrochaeta*), and mosses. *Polystichum aleuticum* is found in moderately protected sites on east-facing slopes characterized by steep cliffs and rock outcrops with numerous overhangs and vegetated gullies and ledges. Underlying rocks are Finger Bay Volcanics-massive and intensely altered andesitic and basaltic flows and pyroclastic rocks. Soils are typic cryandepts, cryofolists, and lithic cryofolists (Lipkin, 1985). They are associated with three vegetation types: (1) A *Salix rotundifolia*-moss type occupying rocky, protected alcoves and cliff ledges under overhanging rock walls (5 plants grow in rock cracks and fractures and on cliff faces); (2) a moist *Salix rotundifolia*- *Carex macrochaeta* (*P. aleuticum*)-moss type in the more exposed and better drained mid- to upper portions of the rock gullies; (3) a moist lower gully-cliff base type of *Carex macrochaeta*-*Anemone narcissiflora*-*Arnica unalaschensis*- (*P. aleuticum*)-moss. In drier vegetation types, *P. aleuticum* grows in clumps on the edge of vegetation mats along rock walls and on the edges of sod clumps or mats that cap exposed rocks or rock outcrops. As cliff walls and rock faces become more rounded and less angular, with fewer cracks and overhangs, sites are more exposed to the elements, and the area is less likely to provide a protected environment for the fern and the compliment of moister site species it is generally associated with. *P. aleuticum* is not found in the *Empetrum nigrum*-lichen-moss heath that characterizes these higher elevation sites, nor does it occur beyond the cliff bases at its lower distributional limit, where the vegetation is a dense, moist to wet, sedge forb meadow association of

Ranunculus escholtzii-Carex macrochaeta. At these lower elevations fronds are buried in the vegetation mat or growing out from under dense, sod overhangs. (Tande, 1989) (NatureServe, 2015). High ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the specific habitat requirements of this species and its narrow geographic range.

### ***Dispersal/Migration***

#### **Dispersal**

Adult: Low (NatureServe, 2015)

#### **Dispersal/Migration Narrative**

Adult: Self-dispersing; wind (NatureServe, 2015). Low dispersal is based on the species restricted habitat requirements which would make dispersal unlikely as well as the majority of the species reproduction being based on clonal reproduction.

### ***Population Information and Trends***

#### **Population Trends:**

Unknown (NatureServe, 2015)

#### **Resiliency:**

Low (NatureServe, 2015)

#### **Representation:**

Low (NatureServe, 2015)

#### **Redundancy:**

Low (NatureServe, 2015)

#### **Population Growth Rate:**

Unknown (NatureServe, 2015)

#### **Number of Populations:**

1 - 5 (NatureServe, 2015)

#### **Population Size:**

1 - 1000 individuals (NatureServe, 2015)

#### **Population Narrative:**

Unclear as to how resistant population is to disturbance. The four known populations are in areas of high natural disturbance, and subject to mortality from mass wasting. Individual plants appear to be adapted to this unstable environment. Unknown Only four populations are known, all on Mt. Reed, Adak I., with 96, 14, and 4 plants respectively (U89TAN01AKUS). *P. aleuticum* is strongly rhizomatous and additional work is needed to define what an individual plant is. Actual number of genetically distinct individual plants is probably much lower than the above cited total. The species is currently known, globally, from only four locations, all on Mt. Reed, Adak I., the Aleutians. A fifth population on Mt. Reed was reported (U88SMI01AKUS) but has not been

verified as either extant or distinct from the other four EO's. The type locality on Atka I. (100 mi east of Adak I.) has not been located since its discovery in 1932. Mt. Reed, Adak I., Atka I. and other islands in the chain have been surveyed for several years, but much additional work is needed before conclusive statements on total EO's can be made. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and the restricted habitat and range of the species.

### ***Threats and Stressors***

**Stressor:** Human impact (USFWS, 2007)

**Exposure:**

**Response:**

**Consequence:** Loss of habitat

**Narrative:** Increases in the human population present on Adak Island, in combination with increases in the caribou population, may expand the area impacted by both of these change agents and further amplify the risk of harm due to habitat destabilization and destruction ) (USFWS, 2007).

**Stressor:** Caribou (USFWS, 2007)

**Exposure:**

**Response:**

**Consequence:** Loss of habitat/loss of individuals

**Narrative:** In 1958 and 1959, 23 barren-ground caribou calves were introduced to Adak Island to provide sport hunting for residents of Naval Air Station, Adak, and as an alternate food source for the military base (Williams and Tutiakoff 2005). The population increased steadily, until in 2005, Williams and Tutiakoff (2005) estimated the herd to number at least 2,751 animals. Although no obvious sign of grazing or trampling was noted in the immediate vicinity of known *P. aleuticum* locations, caribou are regularly seen on the lower slopes of Mt. Reed, and were observed in habitat very similar to that described for the shield fern. Williams and Tutiakoff (2005) described habitat destruction and trailing by caribou as now widespread and common on Adak Island. In addition, more visible evidence of caribou in the vicinity of fern locations was observed in 2005, (Sandy Talbot, pers. comm., 2006). Additionally, caribou were observed to be foraging on *Arnica* spp., a vascular plant documented in association with *P. aleuticum* (Sandy Talbot, pers. comm., 2006). As rangeland quality diminishes, caribou could be expected to seek out locations not previously grazed; thereby increasing the threat these ungulates are thought to pose to *P. aleuticum* (USFWS, 2007).

### ***Recovery***

#### **Reclassification Criteria:**

Criterion 1: "Pending additional information, down-listing could be considered only if significant new populations are discovered" (Service 1992, Executive Summary) (USFWS, 2007).

"“A greenhouse population of a minimum of 1,000 mature sporophytes should be maintained.....” (Anderson 1992, Executive Summary) (USFWS, 2007).

"...genetic material should be stored in a germplasm repository" (Service 1992, Executive Summary).

“The extant population should be protected from disturbance by humans and introduced ungulates” (Service 1992, Executive Summary) (USFWS, 2007).

**Recovery Actions:**

- “Until additional information is obtained on the causes of rarity and the potential for recovery, no precise recovery goal can be set for re-classification to threatened status. However, consideration for re-classification to threatened status could result from the discovery of additional populations” (Service 1992, page 11) (USFWS, 2007). The discovery of 19 additional individuals since 1992 represents a population increase of almost 17%. However, this recovery criterion neither quantifies the population size nor characterizes the spatial distribution of subpopulations that would afford the greatest protection to the species from either unpredictable, destabilizing environmental events, or other disturbance sources. This criterion addresses, albeit incompletely, threats associated with the compounding effects of small population size, restricted gene pool, and restricted distribution (Factor E), and their interaction with the naturally occurring and human-caused threats identified in all 5 Listing Factors (USFWS, 2007).
- The mixed results of first attempts to establish and maintain a greenhouse population of *P. aleuticum* underscore the need to continue investigations into the development of a protocol for spore germination and sporophyte cultivation. A reserve population is important in the mitigation against several threats: 1) it provides living plant material for research that requires destructive sampling (Factor B), 2) it provides living specimens for reintroduction to offset catastrophic natural and anthropogenic losses to the wild population (Factors A, C, and E), and 3) it maintains germplasm (Weinstein 1995) (USFWS, 2007).
- Associated management actions include the determination of the viability of spores during long term storage and the accession of genetic material into an appropriate facility. No progress towards this nonspecific Criterion has been made. Longterm storage of spores is of interest not only for ex situ conservation of *P. aleuticum* but also for taxonomic studies. The length of time over which Pteridophyte spores remain viable varies from species to species and is influenced by other factors, such as spore age, ploidy level, and storage conditions (Aragon and Pangua 2004). Collections of properly stored spores may constitute an important part of the conservation strategy for *P. aleuticum*. Additional investigations into the storage conditions that optimize maintenance of spore viability, genetic integrity and developmental capacity over the longest possible time are required. A spore conservation program may facilitate remediation of losses to the source population resulting from threats identified under all 5 Listing Factors (USFWS, 2007).
- Careful management as laid out in the management plan will be the most effective tool to mediate the effects of predictable threats associated with the activities of island residents, be they human or caribou (Factors A, B, C, and D) (USFWS, 2007).

**Conservation Measures and Best Management Practices:**

- The Recovery Plan should be revised and brought into compliance with current guidelines for recovery planning: criteria should be specifically stated, measurable, and clearly linked to the threats they address; a clear prioritization of management actions deemed integral to achieving recovery of *P. aleuticum* should be provided; and, estimates of the time and cost required to achieve the goal and all intermediate steps should be included. Additional actions to consider (not in priority order) include: • Establish downlisting and delisting criteria that specify population size,

- number of sub-populations, and spatial distribution of sub-populations. • Continue searches for additional populations. • Continue population monitoring with accepted protocol. • Reinvigorate efforts to artificially cultivate and maintain a greenhouse population of mature sporophytes. • Initiate molecular investigations to determine ploidy level. • Reevaluate the desired size of the greenhouse population. • Reevaluate the need for long-term storage of germplasm. • Initiate investigations into optimal long-term germplasm storage conditions and feasibility. • Initiate studies of effects of grazing on shield fern habitat. • Initiate investigations into reintroduction and transplanting. • Develop a caribou management plan. • Conduct feasibility analysis proposed in the Refuge management plan. • Investigate current all-terrain vehicle use patterns. • Establish an outreach plan
- **RECOMMENDATIONS FOR FUTURE ACTIONS** – Although many of the actions identified in the recovery plan have already been accomplished, data gaps for the species and its habitat still remain. We recommend future recovery efforts focus on the following actions to help further our ability to conserve Aleutian shield fern: ☐ Conduct routine surveys of the known populations and attempt to locate the fourth population that has not been found in recent efforts. Surveys should employ photographic monitoring to count plants in order to reduce disturbance to plants and soils in which they occur ☐ Collaborate with USGS to further examine the risk posed by earthquakes and associated landslides/slope stability in areas where the species occurs ☐ Ground truth habitat suitability as determined in Duarte et al. 2012 on slopes located near existing populations to determine suitability for establishing additional populations 17 ☐ Examine feasibility of establishing additional populations in suitable habitat located near existing populations ☐ Continue genetic research into species lineage (USFWS, 2019).

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**SPECIES ACCOUNT: *Polystichum calderonense* (No common name)**

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***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 6/9/1993; Southeast Region (Region 4) (USFWS, 2015)

**Physical Description**

An evergreen terrestrial fern. It has a curved-ascending, 7-mm-thick rhizome which is clothed at the apex with lanceolate to oblong, curved, shining black, marginate scales up to 10 mm long. The fronds are erect to spreading and may reach 60 cm in length. The twice-pinnate blades are lanceolate, 25 to 40 cm long, 6 to 14 cm broad, and narrowed and truncate at the apex. Blades terminate in a scaly proliferous bud which is somewhat narrowed toward the base. This species has 30 to 36 pairs of oblique, short-stalked pinnae. It has a characteristic 4- to 7-cm-long and 0.9- to 1.3-cm-broad middle pinnae. with 8 to 10 pairs of free pinnules. The tissue is dark green, rigid, and opaque. There are 1 to 5 sori located dorsally on the veins of each pinnule. but they are not clearly arranged in rows. The sori are covered by a light brown, deciduous, thin indusium (Proctor 1989). (USFWS, 1994)

**Taxonomy**

Not Available

**Historical Range**

Not Available

**Current Range**

*Polystichum calderonense* is a terrestrial fern that when listed, was known only from the summit of La Silla de Calderon in the Guilarte Commonwealth Forest, and from a private property in Monte Cerrote, in the municipality of Peñuelas (Proctor 1991, USFWS 2010). For these two populations, Proctor (1991) reported 45 and 12 individuals, respectively. However, Jeanine Velez (University of Puerto Rico, Mayaguez Campus) described a third population at the Summit of Monte Guilarte (pers. comm. as cited in Possley and Lange 2016), the fifth highest peak in Puerto Rico (elevation 3,934 ft (1,199 m)). Nevertheless, Possley and Lange (2017) surveyed the area and were unable to find any individuals. An average of 14 plants and recruitment were reported at Silla de Calderon between 2014 and 2017 (Possley and Lange 2017). During these surveys, Possley and Lange (2017) along with Service staff noticed invasive plants species encroaching the area, and remnants of human induced fires just neighboring the *P. calderonense* individuals. On both localities (i.e., Silla Calderon and Monte Guilarte) Possley and Lange (2017) also discovered pockets of suitable habitat for the species. The current status of *P. calderonense* at Monte Cerrote remains unknown. This area has not been surveyed since 1991 (USFWS, 2019).

**Critical Habitat Designated**

Yes;

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

**Reproduction Narrative**

Adult: Not available

**Habitat Type**

Adult: Terrestrial (EPA, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Subtropical wet forest and subtropical moist forest (EPA, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: ~3280 to 3772 ft. elevation (EPA, 2016)

**Environmental Specificity**

Adult: Narrow (inferred from EPA, 2016)

**Habitat Narrative**

Adult: Grows on moist, shady non-calcareous ledges on mountain tops in central and south-central Puerto Rico. Forest is described as subtropical wet forest and subtropical moist forest life zones. It occurs around 3280 to 3772 ft. elevation (EPA, 2016)

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Uncertain (USFWS, 2010)

**Resiliency:**

Low (inferred from USFWS, 2010)

**Representation:**

Low (inferred from USFWS, 2010)

**Redundancy:**

Very low (inferred from USFWS, 2010)

**Number of Populations:**

2 (USFWS, 2010)

**Population Size:**

< 100 (USFWS, 2010)

**Population Narrative:**

The specie status is uncertain; no recent surveys have been conducted for these species and the current population numbers are not known. It is known from two localities comprising less than 100 individuals (USFWS, 2010).

**Threats and Stressors**

**Stressor:** Habitat destruction and modification (USFWS, 2010).

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Polystichum calderonense is threatened by unplanned forest management practices conducted in Commonwealth forests. This species was identified by Proctor (1991, p.153) as vulnerable to cutting or fires. In Peñuelas, according to the Recovery Plan, this species occurs in private lands which may be affected by industrial or residential development (USFWS, 2010).

**Stressor:** Small population size (USFWS, 2010).

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Small population numbers make this species particularly vulnerable to extinction due to the lack of genetic variation necessary to evolve and respond to natural changes.

**Recovery****Reclassification Criteria:**

1. The known populations are placed under protective status (USFWS, 1994).
2. An agreement between the Service and the DNER concerning the protection of this species in Commonwealth forests has been developed and implemented (USFWS, 1994).
3. An agreement between the Service and Cornell University concerning the protection of Tectaria estremerana on the Arecibo Radio Telescope property has been prepared and implemented (USFWS, 1994).
4. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1994).

**Delisting Criteria:**

The amended delisting criteria for Elaphoglossum serpens, Polystichum calderonense, Tectaria estremerana, Thelypteris inabonensis, Thelypteris verecunda, and Thelypteris yaucoensis are as follows: 1. Existing populations (number populations in parentheses) of E. Serpens (2), P. calderonenses (3), T estremerana (3), T verecunda (3), Tinabonensis (2) and T yaucoensis (2) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and Factor E). 2. Establish or discover new populations (number of populations in parentheses) within the historical range of E. serpens (3), T inabonensis (3), T

yaucoensis (3), P calderonense (2), T. estremerana (2), and T. verecunda (2) that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and 3. Threat reduction and management activities have been implemented to a degree that the species is viable for the foreseeable future (addresses Factor A and E) (USFWS, 2019).

**Recovery Actions:**

- Prevent further habitat loss and population decline (USFWS, 1994).
- Continue to gather information on the distribution and abundance of the seven endangered ferns (USFWS, 1994).
- Conduct research on habitat requirements, reproductive biology, and ecology of the seven species (USFWS, 1994).
- Establish new populations (USFWS, 1994).
- Refine recovery goals (USFWS, 1994).

**Conservation Measures and Best Management Practices:**

- Evaluate abundance and distribution through surveys within traditional and non-traditional sites, using the best available plant survey methodology to determine current population numbers, and number of viable populations necessary to protect and stabilize populations (wild, naturally reproducing populations large enough to maintain sufficient genetic variation, and evolve and respond to natural habitat changes) (USFWS, 2010).
- Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects of construction/improvement of communication facilities and forest management practices in Commonwealth forests (USFWS, 2010).
- Review and modify the Puerto Rican Endangered Ferns Recovery Plan which includes these three species to establish delisting criteria. Recovery tasks should be reviewed and implemented (USFWS, 2010).
- Propagation techniques should be developed for the species to establish new self sustainable populations in protected areas (USFWS, 2010).
- Considering all these factors, we recommend the following:
  - The habitat of the two (2) known populations of E. serpens occurring on protected land (i.e., Cerro Punta and Monte Jayuya) need to be fully assessed, and populations enhanced to ensure their resiliency. Specifically, Possley and Lange (2017), and Service biologist O. Monsegur-Rivera recommend a more comprehensive survey that covers a wider area and expands away from the summit of Cerro Punta, a currently very disturbed area where the species was once found. Additionally, three (3) new populations of E. serpens should be established within the Toro Negro Commonwealth Forest or a similar protected habitat (e.g., Monte Guilarte), which genetically represent the known natural populations. Since this is an epiphytic plant, the protection of forest stands that harbor E. serpens common host trees, (e.g., Lyonia Rubiginosa var. stahlii), is also important in order to ensure the species' viability.
  - For P calderonense, the two (2) known populations within Guilarte Commonwealth Forest should be monitored and enhanced to ensure their resiliency. Also, the population within the private property at Cerrote de Peiiuelas needs to be protected through long- term conservation mechanisms (e.g., conservation easements). In order to achieve five viable populations of P calderonenses, two (2) new populations should be established within the Guilarte Commonwealth Forest or areas with similar habitat characteristics and forest plant species communities (e.g., Toro Negro Commonwealth Forest).
  - The two (2) current Tectarea estremerana populations within private properties need to be protected through long-term conservation mechanisms. Also, the population

found at the Rio Abajo Commonwealth Forest should be monitored and enhanced to ensure its resiliency. Additionally, two (2) new populations should be established in properties managed for conservation within the species geographic range. • *Thelypteris verecunda* occurs only on three (3) private properties within the northwest region of Puerto Rico. Therefore, all three populations need to be protected through long-term conservation mechanisms, and two (2) new genetically representative populations need to be established on protected land within its geographic range on suitable habitat for the species. • The two (2) known populations of *T. inabonensis* occur within Toro Negro Commonwealth forest. Since this is protected land, we recommend these two populations need to be monitored and enhanced to ensure their resiliency. Additionally, we recommend the establishment of three (3) new populations also on protected land and within its geographic range. • *Thelypteris yaucoensis* occurs on two (2) private properties within Yauco, and possibly, within protected land at Los Tres Picachos. However, if these two populations are not currently protected, they need to be protected through long-term conservation mechanisms. Additionally, three (3) populations should be established within areas already managed for conservation and within the species geographic range, or sites with similar habitat characteristics and forest plant communities.

**ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS**

1. Genetic material from all species should be preserved through long-term spore storage and/or propagation efforts in institutions authorized by the Service. Priority species for this action are *E. serpens*, *P. calderonense*, and *T. inabonensis* because their taxonomy is not in question. This recovery action should be added to recovery action 33.
2. Establishing new populations outside the current range needs a monitoring and propagation protocol, and pilot studies to ensure appropriate planting sites. To be added to the recovery action 4 (41).
3. Since most agreements and conservation efforts are associated with other Service branches or partner organizations, careful planning for conservation and management needs to be developed and should include partners' education. To be added to recovery action 1 (14).
4. Implement fire and invasive plant species management and control protocols at disturbed areas. This should be added as a new action in the recovery plan (USFWS, 2019).

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## SPECIES ACCOUNT: *Pteris lidgatei* (No common name)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 09/26/1994; Pacific Region (R1) (USFWS, 2016)

### **Physical Description**

*Pteris lidgatei* is a short-lived perennial member of the Adiantaceae (maidenhair fern family). It is a coarse herb, 0.5 to 1 m (1.6 to 3.3 ft) in height arising from a horizontal rhizome 1.5 cm (0.6 in) thick and at least 10 cm (3.9 in) long when mature. The fronds, including the leaf stalks, range in length and width from 60 to 95 cm (24 to 37 ) and 20 to 45 cm (8 to 18 in), respectively. The leafy portion of the frond is oblong-deltoid to broadly ovate-deltoid, thick, brittle, and dark gray-green. The sori are apparently marginal in position, either fused into long linear sori, or more typically separated into distinct shorter sori, with intermediate conditions being common. It can be distinguished from other Hawaiian species in the genus by the rough, brittle texture of its fronds, overall dark green color, and the tendency of the sori along the leaf margins to be broken into short segments rather than fused into a continuous marginal sori (Palmer 2003).

### **Historical Range**

See current range/distribution.

### **Current Range**

*Pteris lidgatei* is an endemic species that historically occurred in the Koolau Mountains of Oahu, and on Maui and Molokai (where it was collected only once in 1912). It has always been rare and in recent years has not been seen in areas where it had been previously observed, though living plants are still being found in new locations on Oahu and Maui (Palmer 2003). On these islands, there are an estimated 45 individuals in eight occurrences. On Oahu, 25 individuals are found as part of six occurrences in Kawainui (3 individuals), Kawai Iki (3), north Kaukonahua (1), south Kaukonahua (14), Kaluanui (1), and Waimano (3). On Maui, 20 individuals are found as part of two occurrences at Kauaula Valley (12) and Kahakuloa Stream (8) (Service 1998b; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP pers. comm. 2003). Ecology On Oahu, *Pteris lidgatei* is generally found on streambanks and near waterfalls. It occurs at approximately 75 m (246 ft) elevation in wet *Metrosideros polymorpha*-*Dicranopteris linearis* forest with *Asplenium* spp, *Broussaisia arguta*, *Cibotium chamissoi*, *Cyrtandra* spp., *Diplopterygium pinnatum*, *Doodia lyonii*, *Dryopteris sandwicensis*, *Elaphoglossum crassifolium*, *Isachne pallens*, *Machaerina angustifolia*, *Sadleria squarrosa*, *Selaginella arbuscula*, and *Sphenomeris chinensis*. *M. polymorpha* is typically the dominant native overstory tree species (HINHP Database 2002; U.S. Army 2003a).

### **Critical Habitat Designated**

Yes; 3/30/2016.

### **Legal Description**

On March 30, 2016, the U.S. Fish and Wildlife Service revised critical habitat for *Pteris lidgatei*. On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for *Pteris lidgatei* under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for *Pteris lidgatei* (77 FR 57648-57862). The critical habitat designation

includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for *Pteris lidgatei* includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

### **Critical Habitat Designation**

Maui—Lowland Wet—Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui—Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet—Unit 7, Maui—Lowland Wet—Unit 8, Maui—Wet Cliff—Unit 6, Maui—Wet Cliff—Unit 7, and Maui—Wet Cliff—Unit 8 constitute critical habitat for *Pteris lidgatei* on Maui. Molokai—Montane Wet—Unit 1, Molokai—Montane Wet—Unit 2, Molokai—Montane Wet—Unit 3, Molokai—Wet Cliff—Unit 1, Molokai—Wet Cliff—Unit 2, and Molokai—Wet Cliff—Unit 3 constitute critical habitat for *Pteris lidgatei* on Molokai.

Maui—Lowland Wet—Unit 2 consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielerectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformum*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), or by the Newcomb's tree snail (*Newcombia cumingi*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta*, *Cyanea asplenifolia*, and *Pteris lidgatei*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Maui—Lowland Wet—Unit 4 consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. They are occupied by the plants *Bidens conjuncta* and *Cyanea asplenifolia*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the

expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *B. micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, *Santalum haleakalae* var. *lanaiense*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Maui—Lowland Wet—Unit 6 consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem. These units are occupied by the plant *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants *Alectryon macrococcus*, *Asplenium dielirectum*, *Bidens conjuncta*, *Bidens micrantha* ssp. *kalealaha*, *Clermontia oblongifolia* ssp. *mauiensis*, *Ctenitis squamigera*, *Cyanea asplenifolia*, *C. glabra*, *C. kunthiana*, *C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *C. munroi*, *Diplazium molokaiense*, *Hesperomannia arborescens*, *H. arbuscula*, *Huperzia mannii*, *Isodendron pyriformium*, *Kadua laxiflora*, *Peucedanum sandwicense*, *Phyllostegia bracteata*, *Pteris lidgatei*, *Remya mauiensis*, or *Wikstroemia villosa*, or by the forest birds, the *akohekohe* (*Palmeria dolei*) and *kiwikiu* (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable

habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

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

Maui—Wet Cliff—Unit 6 consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. They are occupied by the plants *Alectryon macrococcus*, *B. conjuncta*, *Ctenitis squamigera*, *Cyrtandra munroi*, *Remya mauiensis*, and *Santalum haleakalae* var. *lanaiense*. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants *Bidens campylotheca* ssp. *pentamera*, *Bonamia menziesii*, *Cyanea glabra*,

*C. lobata*, *C. magnicalyx*, *Cyrtandra filipes*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. These units are occupied by the plants *Cyrtandra filipes* and *C. munroi*, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants *Alectryon macrococcus*, *Bidens campylotheca* ssp. *pentamera*, *B. conjuncta*, *Bonamia menziesii*, *Ctenitis squamigera*, *Cyanea glabra*, *C. lobata*, *C. magnicalyx*, *Dubautia plantaginea* ssp. *humilis*, *Gouania vitifolia*, *Hesperomannia arborescens*, *H. arbuscula*, *Isodendrion pyrifolium*, *Kadua laxiflora*, *Lysimachia lydgatei*, *Plantago princeps*, *Platanthera holochila*, *Pteris lidgatei*, *Remya mauensis*, *Santalum haleakalae* var. *lanaiense*, or *Tetramolopium capillare*, or by the forest birds, the akohekohe (*Palmeria dolei*) and kiwikiu (*Pseudonestor xanthophrys*), the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

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

Molokai—Montane Wet—Unit 1 consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialeale Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C.*

profuga, *Phyllostegia hispida*, and *Pteris lidgatei*, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant *Melicope reflexa*, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem. This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Montane Wet—Unit 3 is not known to be occupied by *Adenophorus periens*, *Bidens wiebkei*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea mannii*, *C. procera*, *C. profuga*, *C. solanacea*, *Hesperomannia arborescens*, *Lysimachia maxima*, *Phyllostegia hispida*, *P. mannii*, *P. pilosa*, *Platanthera holochila*, *Pteris lidgatei*, *Schiedea laui*, *Stenogyne bifida*, or *Zanthoxylum hawaiiense*, the Service has determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Wet Cliff—Unit 3 consists of 1,137 ac (460 ha) of State land, and 225 ac (91 ha) of privately owned land, along the rim of Wailau Valley from Mapulehu to Kahiwa Gulch, in eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem. Although Molokai—Wet Cliff—Unit 3 is not known to be occupied by *Brighamia rockii*, *Canavalia molokaiensis*, *Clermontia oblongifolia* ssp. *brevipes*, *Cyanea grimesiana* ssp. *grimesiana*, *C. munroi*, *Hesperomannia arborescens*, *Hibiscus arnottianus* ssp. *immaculatus*, *Phyllostegia hispida*, *Pteris lidgatei*, or *Stenogyne bifida*, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for *Pteris lidgatei* includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet—Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park,

from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikēkee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

#### **Primary Constituent Elements/Physical or Biological Features**

(i) In units Maui—Lowland Wet— Unit 2, Maui—Lowland Wet—Unit 3, Maui—Lowland Wet—Unit 4, Maui— Lowland Wet—Unit 5, Maui—Lowland Wet—Unit 6, Maui—Lowland Wet— Unit 7, and Maui—Lowland Wet—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Less than 3,300 ft (1,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Clays; ashbeds; deep, well-drained soils; lowland bogs. (D) Canopy: *Antidesma*, *Metrosideros*, *Myrsine*, *Pisonia*, *Psychotria*. (E) Subcanopy: *Cibotium*, *Claoxylon*, *Kadua*, *Melicope*. (F) Understory: *Alyxia*, *Cyrtandra*, *Dicranopteris*, *Diplazium*, *Machaerina*, *Microlepia*.

(ii) In units Maui—Wet Cliff—Unit 6, Maui—Wet Cliff—Unit 7, and Maui— Wet Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: *Broussaisia*, *Cheirodendron*,

Leptecophylla, Metrosideros. (F) Understory: Bryophytes, ferns, Coprosma, Dubautia, Kadua, Peperomia.

(i) In units Molokai—Montane Wet—Unit 1, Molokai—Montane Wet—Unit 2, and Molokai—Montane Wet—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,500 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

(ii) In units Molokai—Wet Cliff—Unit 1, Molokai—Wet Cliff—Unit 2, and Molokai—Wet Cliff—Unit 3, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, ferns, Coprosma, Dubautia, Kadua, Peperomia.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of *Pteris lidgatei* critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: *Pteris lidgatei* occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

### **Special Management Considerations or Protections**

The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed.

Special management considerations or protections are necessary throughout the critical habitat areas designated for *Pteris lidgatei* to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

***Life History*****Food/Nutrient Resources****Habitat Type**

Adult: Steep streambanks and alongside waterfalls in wet forests (NatureServe, 2015)

**Habitat Narrative**

Adult: Ecology On Oahu, *Pteris lidgatei* is generally found on streambanks and near waterfalls. It occurs at approximately 75 m (246 ft) elevation in wet *Metrosideros polymorpha*-*Dicranopteris linearis* forest with *Asplenium* spp, *Broussaisia arguta*, *Cibotium chamissoi*, *Cyrtandra* spp., *Diplopterygium pinnatum*, *Doodia lyonii*, *Dryopteris sandwicensis*, *Elaphoglossum crassifolium*, *Isachne pallens*, *Machaerina angustifolia*, *Sadleria squarrosa*, *Selaginella arbuscula*, and *Sphenomeris chinensis*. *M. polymorpha* is typically the dominant native overstory tree species (HINHP Database 2002; U.S. Army 2003a).

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

~45 individuals

**Population Narrative:**

It has always been rare and in recent years has not been seen in areas where it had been previously observed, though living plants are still being found in new locations on Oahu and Maui (Palmer 2003). On these islands, there are an estimated 45 individuals in eight occurrences. On Oahu, 25 individuals are found as part of six occurrences in Kawaiinui (3 individuals), Kawai Iki (3), north Kaukonahua (1), south Kaukonahua (14), Kaluanui (1), and Waimano (3). On Maui, 20 individuals are found as part of two occurrences at Kauaula Valley (12) and Kahakuloa Stream (8) (Service 1998b; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP pers. comm. 2003).

***Threats and Stressors*****Stressor:****Exposure:****Response:****Consequence:**

**Narrative:** The major threats to *Pteris lidgatei* include habitat degradation and consumption by feral pigs, competition from non-native plants, potential effects of on-going and future Army training activities, and the risk of extinction due to the small number of remaining individuals and stochastic events. The non-native plants *Ageratina riparia*, *Christella parasitica*, *Clidemia hirta*, *Paspalum conjugatum*, *Psidium cattleianum*, *Pterolepis glomerata*, *Sacciolepis indica* threaten *P. lidgatei* by altering its habitat and competing with it for nutrients, light, and space (Service 1998b).

**Recovery****Conservation Measures and Best Management Practices:**

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Pteris lidgatei*. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions: construction of exclosures protect the known occurrences from feral pigs and goats, subsequent control and/or removal of ungulates, and removal of competitive non-native plant species. Priority for all of these actions should be given to those occurrences with only a few individuals (e.g., north Kaukonahua, Kaluanui). Additional surveys are also needed throughout suitable habitat to locate new occurrences and update the status of those occurrences that have not been seen in over 20 years (Service 1998b). On-going Conservation Actions: The Nature Conservancy of Hawaii's ungulate control program in Kapunakea Preserve on Maui includes construction of fences to protect rare plants, annual monitoring of ungulates, and trained staff and volunteer hunting (68 FR 25934). These efforts have reduced the spread of feral pigs into the nearby area in Kauaula Valley where an occurrence of *Pteris lidgatei* is found (Service 1998b). The Service is not aware of any other conservation actions are being implemented for this species.

**References**

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Endangered Status for 23 Species on Oahu and Designation of Critical Habitat for 124 Species. Final Rule. 77 FR 57648-57862 (September 18, 2012)

**SPECIES ACCOUNT: *Tectaria estremerana* (No common name)**

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***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 6/9/1993; Southeast Region (Region 4) (USFWS, 2015)

**Physical Description**

Species has a woody, erect. 10- to 15-mm-thick rhizome. The rhizome's apex bears a dense tuft of erect, brown, glabrous, narrowly deltate-at-tenuate scales about 15 mm long and 0.5 to 0.8 mm wide at the base. This fern has several loosely fasciculate, 65- to 80- cm-long fronds. The light orange-brown stipes are slightly shorter than the blades and are covered with pale jointed hairs. Scales up to 12 mm long clothe the base. The blades are oblong-ovate, 35 to 41 cm long, 20 to 25 cm broad below the middle, and acuminate at the pinnatifid apex. The rachis, the costae, and the costules are softly puberulous with articulate hairs on both sides. This fern has 3 to 4 pairs of free pinnae, and has several distal divisions which are more or less adnate. The basal pair of pinnae is deltate-oblong, strongly inequilateral, 12 to 13 cm long, and coarsely lobate or subpinnatifid. The lobes are from 9 to 13 mm broad except for the larger basal basiocopic ones. The tissue is firmly herbaceous. glabrous, but the margins are ciliate. The sori are located nearer to the midvein than the margin of the pinna-lobes (Proctor 1989). (USFWS, 1994)

**Taxonomy**

Not Available

**Historical Range**

Not Available

**Current Range**

known from only one site located in the municipality of Arecibo, within the property of the Arecibo Radio Telescope managed by Cornell University under a cooperative agreement from National Science Foundation. Approximately 23 individual plants were found in the area (Proctor 1989). Dr. Franklin Axelrod, in a letter dated September 9, 1994, mentioned that this species was collected by him in the Rio Abajo Commonwealth Forest in Arecibo and in a sinkhole near an old quarry in Florida, Abajo Ward in the municipality of Florida. (USFWS, 1994)

**Critical Habitat Designated**

Yes;

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial (EPA, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Subtropical moist forest (EPA, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: ~820 to 984 ft. elevation (EPA, 2016)

**Environmental Specificity**

Adult: Narrow (inferred from EPA, 2016)

**Habitat Narrative**

Adult: Limestone hills of northern Puerto Rico; Karst region. Occurs in semi-evergreen seasonal forests of the subtropical moist forest life zone. Grows in moist shaded humus on (epiphytic) and among limestone boulders on wooded rocky hillside. Collection also made at a sinkhole in a quarry in Florida. Occurs around 820 to 984 ft. in elevation (EPA, 2016).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Not available

**Number of Populations:**

3 (USFWS, 2010)

**Population Size:**

23+ (USFWS, 2010)

**Population Narrative:**

The species status is uncertain; no recent surveys have been conducted for these species and the current population numbers are not known. Twenty-three individuals of *T. estremerana* were found at its only known location in the limestone hills of northern Puerto Rico (Arecibo). This species was later collected in the Río Abajo Commonwealth Forest in Arecibo and in a sinkhole near an old quarry at Florida Adentro Ward in the municipality of Florida. (USFWS, 2010).

***Threats and Stressors***

**Stressor:** Development (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The plan establishes that the population is located about 200 meters south of the telescope which makes the species vulnerable to any expansion or development of the facilities. Funds are limited for these facilities and their operation. In case these facilities are abandoned,

new land uses that could possibly affect *T. estremerana* may be proposed in the future (USFWS, 2010).

**Stressor:** Small population size (USFWS, 2010)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Small population numbers make this species particularly vulnerable to extinction due to the lack of genetic variation necessary to evolve and respond to natural changes (USFWS, 2010).

### ***Recovery***

#### **Reclassification Criteria:**

1. The known populations are placed under protective status (USFWS, 2010).
2. An agreement within the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) concerning the protection of this species in Commonwealth forests has been developed and implemented (USFWS, 2010).
3. An agreement within the Service and Cornell University concerning the protection of *Tectaria estremerana* on the Arecibo Radio Telescope has been prepared and implemented (USFWS, 2010).
4. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 2010).

#### **Delisting Criteria:**

The amended delisting criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* are as follows: 1. Existing populations (number populations in parentheses) of *E. Serpens* (2), *P. calderonenses* (3), *T. estremerana* (3), *T. verecunda* (3), *Tinabonensis* (2) and *T. yaucoensis* (2) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and Factor E). 2. Establish or discover new populations (number of populations in parentheses) within the historical range of *E. serpens* (3), *T. inabonensis* (3), *T. yaucoensis* (3), *P. calderonense* (2), *T. estremerana* (2), and *T. verecunda* (2) that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and 3. Threat reduction and management activities have been implemented to a degree that the species is viable for the foreseeable future (addresses Factor A and E) (USFWS, 2019).

#### **Recovery Actions:**

- Prevent further habitat loss and population decline (USFWS, 1994).
- Continue to gather information on the distribution and abundance of the seven endangered ferns (USFWS, 1994).

- Conduct research on habitat requirements, reproductive biology, and ecology of the seven species (USFWS, 1994).
- Establish new populations (USFWS, 1994).
- Refine recovery goals (USFWS, 1994).

***Conservation Measures and Best Management Practices:***

- Evaluate abundance and distribution through surveys within traditional and non-traditional sites, using the best available plant survey methodology to determine current population numbers, and number of viable populations necessary to protect and stabilize these three fern populations (wild, naturally reproducing populations large enough to maintain sufficient genetic variation, and evolve and respond to natural habitat changes) (USFWS, 2010).
- Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects of construction/improvement of communication facilities and forest management practices in Commonwealth forests (USFWS, 2010).
- Review and modify the Puerto Rican Endangered Ferns Recovery Plan which includes these three species to establish delisting criteria. Recovery tasks should be reviewed and implemented (USFWS, 2010).
- Propagation techniques should be developed for the species to establish new self sustainable populations in protected areas (USFWS, 2010).
- Considering all these factors, we recommend the following:
  - The habitat of the two (2) known populations of *E. serpens* occurring on protected land (i.e., Cerro Punta and Monte Jayuya) need to be fully assessed, and populations enhanced to ensure their resiliency. Specifically, Possley and Lange (2017), and Service biologist O. Monsegur-Rivera recommend a more comprehensive survey that covers a wider area and expands away from the summit of Cerro Punta, a currently very disturbed area where the species was once found. Additionally, three (3) new populations of *E. serpens* should be established within the Toro Negro Commonwealth Forest or a similar protected habitat (e.g., Monte Guilarte), which genetically represent the known natural populations. Since this is an epiphytic plant, the protection of forest stands that harbor *E. serpens* common host trees, (e.g., *Lyonia Rubiginosa* var. *stahlii*), is also important in order to ensure the species' viability.
  - For *P. calderonense*, the two (2) known populations within Guilarte Commonwealth Forest should be monitored and enhanced to ensure their resiliency. Also, the population within the private property at Cerrote de Peiuelas needs to be protected through long-term conservation mechanisms (e.g., conservation easements). In order to achieve five viable populations of *P. calderonenses*, two (2) new populations should be established within the Guilarte Commonwealth Forest or areas with similar habitat characteristics and forest plant species communities (e.g., Toro Negro Commonwealth Forest).
  - The two (2) current *Tectarea estremerana* populations within private properties need to be protected through long-term conservation mechanisms. Also, the population found at the Rio Abajo Commonwealth Forest should be monitored and enhanced to ensure its resiliency. Additionally, two (2) new populations should be established in properties manage for conservation within the species geographic range.
  - *Thelypteris verecunda* occurs only on three (3) private properties within the northwest region of Puerto Rico. Therefore, all three populations need to be protected through long-term conservation mechanisms, and two (2) new genetically representative populations need to be established on protected land within its geographic range on suitable habitat for the species.
  - The two (2) known populations of *T. inabonensis* occur within Toro Negro Commonwealth forest. Since this is protected land, we recommend these two populations needs to be monitored and enhanced to ensure their resiliency. Additionally, we recommend the establishment of three (3) new populations also on protected land and within its geographic range.

- *Thelypteris yaucoensis* occurs on two (2) private properties within Yauco, and possibly, within protected land at Los Tres Picachos. However, if these two populations are not currently protected, they need to be protected through long-term conservation mechanisms. Additionally, three (3) populations should be established within areas already managed for conservation and within the species geographic range, or sites with similar habitat characteristics and forest plant communities.
- ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS
1. Genetic material from all species should be preserved through long-term spore storage and/or propagation efforts in institutions authorized by the Service. Priority species for this action are *E. serpens*, *P. calderonenses*, and *T. inabonensis* because their taxonomy is not in question. This recovery action should be added to recovery action 33.
  2. Establishing new populations outside the current range needs a monitoring and propagation protocol, and pilot studies to ensure appropriate planting sites. To be added to the recovery action 4 (41).
  3. Since most agreements and conservation efforts are associated with other Service branches or partner organizations, careful planning for conservation and management needs to be developed and should include partners' education. To be added to recovery action 1 (14).
  4. Implement fire and invasive plant species management and control protocols at disturbed areas. This should be added as a new action in the recovery plan (USFWS, 2019).

## References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. <http://ecos.fws.gov/speciesProfile/>. Accessed April 2016.

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USFWS 2010. *Elaphoglossum serpens* (no common name) *Polystichum calderonense* (no common name) *Tectaria estremerana* (no common name) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

**SPECIES ACCOUNT: *Thelypteris inabonensis* (No common name)**

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***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 7/2/1993; Southeast Region (Region 4) (USFWS, 2015)

**Physical Description**

A terrestrial fern with an erect and slender (ca 0.5 cm diameter) rhizome which is clothed at the apex with numerous dark lustrous brown, and densely setulose scales. The fronds are erect arching. up to 60 cm long. The stipes are 5 to 10 cm long and clothed with grayish, acicular hairs, and have numerous spreading scales similar to those of the rhizome. This species differs from all other Puerto Rican thelypterid ferns due to the presence of scales and acicular hairs on the rachis. The blades are narrowly elliptic, up to 55 cm long. The species has 25 to 30 pairs of sessile pinnae, rounded at the apex, and with up to seven pairs of simple veins. The tissue has numerous short, erect. acicular hairs and lacks glands. The small son, which has a densely long-ciliate indusium, are located dorsal on veins (Proctor 1989). (USFWS, 1994)

**Taxonomy**

In the Family Thelypteridaceae, Order Polypodiales (USFWS, 1994). One common name is cordillera maiden fern (ITIS, 2017).

**Historical Range**

Not Available

**Current Range**

Known from two localities in the Toro Negro Commonwealth Forest: the headwaters of the Rio Inabon in Ponce and Cerro Rosa in Ciales. Forty-six plants were counted in both localities combined (Proctor 1991) (USFWS, 1994)

**Critical Habitat Designated**

Yes;

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial (USFWS, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Wet montane forest (USFWS, 2015)

**Geographic or Habitat Restraints or Barriers**

Adult: 3,674.5-4,121 ft (1,120-1,250 m) elevation (USFWS, 2015)

**Environmental Specificity**

Adult: Very narrow (inferred from USFWS, 2015)

**Habitat Narrative**

Adult: Thelypteris inabonensis is known from two localities, both in wet montane forests at high elevations in the Toro Negro Commonwealth Forest. Thelypteris inabonensis grows along stream banks in sierra palm (Prestoea montana) forests, and mossy forests with sierra palms in deeply-shaded humus near the summit area (3,674.5-4,121 ft (1,120-1,250 m) within the lower montane forest life zone (Ewel and Whitmore 1973) (USFWS, 2015).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: Not available

***Population Information and Trends*****Population Trends:**

Declining (USFWS, 1994)

**Species Trends:**

Unknown (USFWS, 2015)

**Resiliency:**

Very low (inferred from USFWS, 1994).

**Representation:**

Very low (inferred from USFWS, 1994)

**Redundancy:**

Very low (inferred from USFWS, 1994)

**Number of Populations:**

2 (USFWS, 1994)

**Population Size:**

46 (USFWS, 1994)

**Population Narrative:**

This species was known from 46 individuals in two localities in the Toro Negro Commonwealth Forest (Proctor 1991) (USFWS 1994). The species status is unknown; the status and distribution of T. inabonensis has not been reevaluated since 1995 (USFWS 1995). (USFWS, 2015).

***Threats and Stressors***

**Stressor:** Limited distribution (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Thelypteris inabonensis* is vulnerable to extinction due to low population numbers and restricted distribution. The low number of individuals and limited geographic range may also exacerbate their vulnerability to natural or anthropogenic events such as hurricanes, landslides, low genetic variation, and habitat modification, compromising the continued existence of the species (USFWS 1995) (USFWS, 2015).

**Stressor:** Genetic Variation (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Given the limited geographic distribution of *T. inabonensis*, it is highly likely that genetic variability is low. In rare species like this ferns, genetic variation is very important because the loss of genetic variation can reduce the ability of the species to adapt to environmental changes. In addition, it may increase the susceptibility to diseases and pests. This is highlighted by the fact that this species shows a low number of populations with a low number of individuals (USFWS, 2015)

**Stressor:** Climate change (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (IPCC 2007, Glick et al. 2011). Therefore, shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Numerous plant species in Puerto Rico survived the deforestation that occurred in the Island during the early 1930s. Some species, however, survived that deforestation and are now restricted to forests remnants. Climate change may alter or modify the microclimatic conditions of those remnants where *T. inabonensis* occurs. Under this scenario, these populations may be displaced or outcompeted by native or exotic species with wider environmental plasticity (USFWS, 2015).

**Stressor:** Stochastic events (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** As species endemic to the Caribbean, *T. inabonensis* should be well adapted to tropical disturbance. However, as stated in the final rule, the low number of populations and individuals pose a threat to the species by making it susceptible to stochastic events such as hurricanes. Additionally, heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides, which are part of the forest dynamics. A massive landslide in areas where this species grows would not only take out the adult ferns and their offsprings, but their habitats as well. Even a small landslide would provide an opening in the vegetation that would allow other plants (native or non-native, herbaceous or woody) to become established. Moreover, the frequency and severity is expected to increase due to climate change (Hopkinson et al. 2008) (USFWS, 2015).

**Recovery**

**Reclassification Criteria:**

1. The known populations are placed under protective status (USFWS, 1994).
2. An agreement between the Service and the DNER concerning the protection of this species in Commonwealth forests has been developed and implemented (USFWS, 1994).
3. An agreement between the Service and Cornell University concerning the protection of *Tectaria estremerana* on the Arecibo Radio Telescope property has been prepared and implemented (USFWS, 1994).
4. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1994).

**Delisting Criteria:**

The amended delisting criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* are as follows: 1. Existing populations (number populations in parentheses) of *E. Serpens* (2), *P. calderonenses* (3), *T. estremerana* (3), *T. verecunda* (3), *Tinabonensis* (2) and *T. yaucoensis* (2) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and Factor E). 2. Establish or discover new populations (number of populations in parentheses) within the historical range of *E. serpens* (3), *T. inabonensis* (3), *T. yaucoensis* (3), *P. calderonense* (2), *T. estremerana* (2), and *T. verecunda* (2) that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and 3. Threat reduction and management activities have been implemented to a degree that the species is viable for the foreseeable future (addresses Factor A and E) (USFWS, 2019).

**Recovery Actions:**

- Prevent further habitat loss and population decline. Protection of habitat and individual plants at known population sites should be initiated by appropriate public agencies and entities (DNER, Service, Cornell University) and private organizations (USFWS, 1994).
- Continue to gather information on the distribution and abundance of the seven endangered ferns. Additional information concerning the distribution and abundance of the species may affect future management decisions and the establishment of recovery priorities (USFWS, 1994).
- Conduct research on habitat requirements, reproductive biology, and ecology of the seven species. Basic biological information is currently needed for the seven fern species. Studies should focus on aspects of life history, methods of propagation, and evaluation of possible introduction sites. These studies may be critical in the recovery of the species (USFWS, 1994).
- Establish new populations. Areas for the establishment of new populations of the seven fern species should be selected and new populations established (USFWS, 1994).
- Refine recovery goals. As additional information on the biology, ecology, propagation, and management of these seven fern species is gathered, it will be necessary to better define, and possibly modify, recovery goals. (USFWS, 1994).

**Conservation Measures and Best Management Practices:**

- Conduct a comprehensive status survey of these species to evaluate the abundance and distribution of *Thelypteris inabonensis* in Puerto Rico. Surveys should include both traditional and non-traditional sites (USFWS, 2015).
  - Once thorough surveys are conducted, a PVA would be needed to determine the number of self-sustainable populations needed to protect and delist this species (USFWS, 2015).
  - Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of this species (USFWS, 2015).
  - Efforts to protect populations within privately owned lands should be initiated to reduce habitat deterioration and promote sustainable land use practices (USFWS, 2015).
  - Develop propagation techniques for *Thelypteris inabonensis* to establish new self-sustainable populations in protected areas (USFWS, 2015).
  - Considering all these factors, we recommend the following:
    - The habitat of the two (2) known populations of *E. serpens* occurring on protected land (i.e., Cerro Punta and Monte Jayuya) need to be fully assessed, and populations enhanced to ensure their resiliency. Specifically, Possley and Lange (2017), and Service biologist O. Monsegur-Rivera recommend a more comprehensive survey that covers a wider area and expands away from the summit of Cerro Punta, a currently very disturbed area where the species was once found. Additionally, three (3) new populations of *E. serpens* should be established within the Toro Negro Commonwealth Forest or a similar protected habitat (e.g., Monte Guilarte), which genetically represent the known natural populations. Since this is an epiphytic plant, the protection of forest stands that harbor *E. serpens* common host trees, (e.g., *Lyonia Rubiginosa* var. *stahlii*), is also important in order to ensure the species' viability.
    - For *P. calderonense*, the two (2) known populations within Guilarte Commonwealth Forest should be monitored and enhanced to ensure their resiliency. Also, the population within the private property at Cerrote de Peiiuelas needs to be protected through long-term conservation mechanisms (e.g., conservation easements). In order to achieve five viable populations of *P. calderonense*, two (2) new populations should be established within the Guilarte Commonwealth Forest or areas with similar habitat characteristics and forest plant species communities (e.g., Toro Negro Commonwealth Forest).
    - The two (2) current *Tectarea estremeirana* populations within private properties need to be protected through long-term conservation mechanisms. Also, the population found at the Rio Abajo Commonwealth Forest should be monitored and enhanced to ensure its resiliency. Additionally, two (2) new populations should be established in properties managed for conservation within the species geographic range.
    - *Thelypteris verecunda* occurs only on three (3) private properties within the northwest region of Puerto Rico. Therefore, all three populations need to be protected through long-term conservation mechanisms, and two (2) new genetically representative populations need to be established on protected land within its geographic range on suitable habitat for the species.
    - The two (2) known populations of *T. inabonensis* occur within Toro Negro Commonwealth forest. Since this is protected land, we recommend these two populations need to be monitored and enhanced to ensure their resiliency. Additionally, we recommend the establishment of three (3) new populations also on protected land and within its geographic range.
    - *Thelypteris yaucoensis* occurs on two (2) private properties within Yauco, and possibly, within protected land at Los Tres Picachos. However, if these two populations are not currently protected, they need to be protected through long-term conservation mechanisms. Additionally, three (3) populations should be established within areas already managed for conservation and within the species geographic range, or sites with similar habitat characteristics and forest plant communities.
- ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS 1. Genetic material from all species should be

preserved through long-term spore storage and/or propagation efforts in institutions authorized by the Service. Priority species for this action are *E. serpens*, *P. calderonenses*, and *T. inabonensis* because their taxonomy is not in question. This recovery action should be added to recovery action 33. 2. Establishing new populations outside the current range needs a monitoring and propagation protocol, and pilot studies to ensure appropriate planting sites. To be added to the recovery action 4 (41). 3. Since most agreements and conservation efforts are associated with other Service branches or partner organizations, careful planning for conservation and management needs to be developed and should include partners' education. To be added to recovery action 1 (14). 4. Implement fire and invasive plant species management and control protocols at disturbed areas. This should be added as a new action in the recovery plan (USFWS, 2019).

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USFWS 2015. *Thelypteris unabonensis* (no common name). *Thelypteris verecunda* (no common name). *Thelypteris yaucoensis* (no common name)

## **SPECIES ACCOUNT: *Thelypteris pilosa* var. *alabamensis* (Alabama streak-sorus fern (=T. burksorium))**

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### ***Species Taxonomic and Listing Information***

**Listing Status:** Threatened; 7/8/1992; Southeast Region (Region 4) (USFWS, 2015)

### **Physical Description**

An evergreen fern with clustered fronds that develop from a short, slender rhizome. Fronds attain 3.3 cm in width and 2 cm in length but are generally shorter; the blade is sinuately lobed, with the lower pinnae separate and short stalked, becoming sessile upward. Both surfaces of the blade are covered with many slender needle-shaped hairs, especially on the axes and veins. (NatureServe, 2015)

### **Taxonomy**

Recognized as the full species *Thelypteris burksorium* by Watkins and Farrar (2002, 2005). Some Mexican populations were considered to be included in this taxon by Flora of North America (1993), but studies have shown Alabama plants to be genetically and morphologically distinct (Watkins and Farrar 2002, 2005). (NatureServe, 2015)

### **Historical Range**

The minimum historical distribution of *T. pilosa* var. *alabamensis* is assumed to include an estimated 4.25 mile segment of the Sipsey Fork, plus the stretch of stream, now inundated, between this 4.25-mile segment of river and the destroyed type locality. It is probable that the species also occurred downstream of the type locality and perhaps even on some tributaries such as Rockhouse Creek or Brushy Creek. (NatureServe, 2015)

### **Current Range**

Restricted to a 4 mile stretch of Sipsey Fork, a tributary of the Black Warrior River in Alabama. (NatureServe, 2015)

### **Critical Habitat Designated**

No;

### ***Life History***

### **Food/Nutrient Resources**

### **Reproductive Strategy**

Adult: Sexual (inferred from USFWS, 2014)

### **Breeding Season**

Adult: Year round (EPA, 2016)

### **Reproduction Narrative**

Adult: It produces spores year round (EPA, 2016). This species has been shown to produce dwarfed viable sporophytes, but also undergoes a highly unusual form of gametophytic

proliferation, indicating that it has distinct gametophyte morphology (Watkins and Farrar 2002) (USFWS, 2014).

**Habitat Type**

Adult: Terrestrial, palustrine (NatureServe, 2015)

**Habitat Vegetation or Surface Water Classification**

Adult: Bare rock/talus/scree, forest, riparian

**Dependencies on Specific Environmental Elements**

Adult: High humidity, high substrate moisture, shade (NatureServe, 2015); diffuse light (EPA, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: 10 - 60 ft. above river (EPA, 2016)

**Spatial Arrangements of the Population**

Adult: Linear (see threats)

**Environmental Specificity**

Adult: Very narrow (NatureServe, 2015)

**Habitat Narrative**

Adult: Moist sandstone surfaces, usually under rock overhangs or on exposed cliff faces, and either directly above a stream or nearby. Sites vary from completely shaded to partially sunny. Moisture comes from water seeping over the sandstone from up-slope runoff and, for sites directly above the stream, from water vapor. Associates include various bryophytes and climbing hydrangea (*Decumaria barbara*). Grows on shaded moist ledges of sandstone which forms massive bluffs. Plants usually are scattered in moss and liverwort mats in the crevices of the bluffs. Shade is provided by a bluff and ravine forest of hemlock, various cove-type hardwoods including *Quercus rubra*, *Q. alba*, ash, tulip poplar, elm, maple, *Betula lenta*, etc. Habitat for this rare fern is maintained by a combination of high humidity, high substrate moisture, and shade, the humidity provided by evaporation from the stream, the substrate moisture by seepage over the sandstone and bryophyte mats, the shade by overhanging branches of trees which also tend to trap the moist air. Danger to the fern could come from logging of the bluff woodlands, this admitting too much light, reducing humidity, thus generally contributing to a drying out and destruction of the habitat (Kral 1983). The environmental specificity is very narrow (NatureServe, 2015). It occurs in a 4.25 mile segment of Sipsey Fork, a tributary of the Black Warrior River. Plants root in crevices and on rough rock surfaces of Pottsville sandstone bluffs along the river. Plants usually occur hanging from sandstone overhangs (rockhouses) and recessed walls, on ledges beneath overhangs, and on exposed cliff faces. A few occurrences of the plant are in moist seepage areas on exposed vertical rock faces. Fern microhabitat is maintained by surface moisture seepage over the sandstone where the fern is growing as well as high humidity. Usually a minimum of 10 ft. above the water level. Requires diffuse light. The herbaceous community is considered the hemlock-hardwood forest association ( a bluff ravine forest dominated by hemlock and other cove hardwood species). It occurs 10 to 60 ft. above the river (EPA, 2016). All known Alabama occurrences of the Alabama streak-sorus fern are found on Pottsville sandstone, where plants grow in crevices and rough

surfaces on the roofs and floors of sandstone rockhouses formed along these cliffs (Watkins and Farrar 2002) (USFWS, 2014).

### ***Dispersal/Migration***

#### **Dispersal/Migration Narrative**

Adult: Not available

### ***Population Information and Trends***

#### **Population Trends:**

Unknown (NatureServe, 2015)

#### **Species Trends:**

Stable (USFWS, 2014)

#### **Resiliency:**

Very low (inferred from NatureServe, 2015)

#### **Representation:**

High (inferred from NatureServe, 2015 and USFWS, 2014)

#### **Redundancy:**

Very low (inferred from NatureServe, 2015)

#### **Number of Populations:**

2 (NatureServe, 2015)

#### **Population Size:**

2500 - 10,000 individuals (NatureServe, 2015)

#### **Population Narrative:**

The long term population trend is unknown. Currently, the known range of this species is limited to a 4 mile stretch along a single river tributary in Winston County, Alabama. It is locally abundant there, with at least 2 extensive populations. Population sizes are highly variable, with the smallest occurrence containing only one plant whereas the largest contains 6,500 individuals (NatureServe, 2015). The species status is stable; surveys indicate the fern continues to be found in the same locations it was a decade ago (USFWS, 2014).

### ***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** This species continues to be threatened by future road or dam construction projects, and rises in the downstream reservoir; however, long term changes in reservoir pool levels are not possible without significant structural modifications to Lewis Smith Dam. Logging above the

occupied sites could adversely affect the microhabitat needed by the species by removing the canopy cover and thereby reducing the shaded conditions and humidity levels. Additionally, the forest is currently faced with an infestation of hemlock wooly adelgid, an invasive insect that seriously damages hemlock ecosystems. Losing hemlock trees in the vicinity of the ferns locations could reduce shaded conditions and high humidity levels needed by the species. The species also continues to be threatened by recreational use of the river corridor, loss of forest cover from fire, timbering on the slopes overlooking the river, or loss of hemlock trees leading to changes in shade, humidity, and moisture gradients in fern habitat, and development of private inholdings (USFWS, 2014).

**Stressor:** Stochastic events (USFWS, 2014)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The greatest threat to the Alabama streak-sorus fern is its vulnerability due to its extremely restricted range and the relatively small number of plants comprising its population. Because the fern is located in a linear stretch of the Sipsey Fork, a single, natural or human-induced catastrophic disturbance could eliminate or seriously reduce the size of the existing populations. Natural threats, such as severe flooding or drought, or erosional collapse of sandstone overhangs, could dramatically reduce the number of plants throughout the range, or completely eliminate some sites (USFWS, 2014).

### ***Recovery***

**Reclassification Criteria:**

Not available

**Delisting Criteria:**

The population on the Sipsey Fork, and at least two other populations in different drainages, are protected and determined to be viable (USFWS, 2014).

**Recovery Actions:**

- Protect populations (USFWS, 1996).
- Search for new occurrences (USFWS, 1996).
- Maintain plants in cultivation (USFWS, 1996).
- Develop management plans (USFWS, 1996).
- Monitor populations (USFWS, 1996).
- Establish additional populations, if found to be necessary (USFWS, 1996).

***Conservation Measures and Best Management Practices:***

- Initiate at least semi-annual long-term monitoring on sites located on the Sipsey Fork (USFWS, 2014).
- Attempt to locate additional populations in nearby drainages (USFWS, 2014).
- Work to obtain protection for sites on privately-owned lands (USFWS, 2014).
- Research life history parameters and propagation techniques (USFWS, 2014).
- Continue to work cooperatively with the Bankhead National Forest to evaluate potential impacts to the plant from recreational use and implement corrective measures (USFWS, 2014).

- Enter into an MOU to work toward the recovery of this plant through the development of conservation measures (USFWS, 2014).

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**SPECIES ACCOUNT: *Thelypteris verecunda* (No common name)**

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***Species Taxonomic and Listing Information***

**Listing Status:** Endangered; 7/2/1993; Southeast Region (Region 4) (USFWS, 2015)

**Physical Description**

A terrestrial fern with creeping. 2- to 3-mm thick rhizomes. The apex bears brown scales, 1 mm long and 0.5 mm wide. The species has dimorphic fronds which are clothed throughout with star shaped hairs, and numerous much longer simple hairs. The stipes or stalks are 1 to 1.5 cm long and 0.4 to 0.5 mm thick. The sterile blades are oblongate, 2.5 to 4 cm long, 1.5 to 2 cm broad, truncate at the base, and rounded at the broadly-lobed apex. The sterile blades have 2 to 4 pairs of short-stalked, round-oblong. 0.8 to 1 cm long and 0.4 to 0.6 cm wide, entire pinnae with simple veins. The fertile blades are 2 linear to attenuate, 13 to 15 cm long, 1.2 to 1.8 cm broad, truncate at the base, and the rachis bears a minute proliferous bud below the apex. These blades have 15 to 20 pairs of mostly rounded-oblong to oval, 0.3 to 0.4 cm wide, short-stalked, entire pinnae. The small and erect son, which have a minute indusium, are located in an inframedial position, and bear a tuft of long, white, simple hair (Proctor 1989). (USFWS, 1994)

**Taxonomy**

Not Available

**Historical Range**

Not Available

**Current Range**

It is found at three localities: Charcas Ward in Quebradillas, Bayaney Ward in Hatillo, and Cidral Ward in the municipality of San Sebastian. In Bayaney Ward about 20 plants are known (Proctor 1991). All of these localities are privately owned lands. (USFWS, 1994)

**Critical Habitat Designated**

Yes;

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial (EPA, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Subtropical moist forest (EPA, 2016)

**Habitat Narrative**

Adult: Karst or limestone region of northwestern Puerto Rico. Occurs within semi-evergreen seasonal forests of the subtropical moist forest life zone (EPA, 2016).

### ***Dispersal/Migration***

#### **Dispersal/Migration Narrative**

Adult: Dispersal occurs via abiotic factors (EPA, 2016).

### ***Population Information and Trends***

#### **Population Trends:**

Not available

#### **Species Trends:**

Unknown (USFWS, 2015)

#### **Resiliency:**

Low (inferred from USFWS, 1994)

#### **Redundancy:**

Low (inferred from USFWS, 1994)

#### **Number of Populations:**

3 (USFWS, 1994)

#### **Population Narrative:**

The species is unknown; the status and distribution of *T. verecunda* has not been reevaluated since 1995 (USFWS 1995) (USFWS, 2015). *Thelypteris verecunda* is found at three localities (USFWS, 1994).

### ***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** The Puerto Rico Planning Board classified Bayaney ward in the municipality of Hatillo and Cidral ward in the municipality of San Sebastián as Districts of General Agriculture (AG). This classification allows agricultural development such as planting of agricultural products and cattle grazing. On the other hand, the Puerto Rico Planning Board classified Charcas ward in the municipality of Quebradillas as a District of Conservation Resource 1 (CR-1, the most restrictive for development, precluding tourist and residential development activities). This classification though, allows agricultural (e.g. cattle grazing) and rural developments. Therefore, clearing or development in these areas could have adverse effects on *T. verecunda* (USFWS, 2015).

**Stressor:** Limited distribution (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *T. verecunda* is vulnerable to extinction due to low population numbers and restricted distribution. The low number of individuals and limited geographic range may also exacerbate its vulnerability to natural or anthropogenic events such as hurricanes, landslides, low genetic variation, and habitat modification, compromising the continued existence of this species (USFWS1995). In rare species like this fern, genetic variation is very important because the loss of genetic variation can reduce the ability of these species to adapt to environmental changes. In addition, it may increase the susceptibility to diseases and pests. This is highlighted by the fact that this species shows a low number of populations with a low number of individuals (USFWS, 2015).

**Stressor:** Stochastic events (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** As a species endemic to the Caribbean, *T. verecunda* should be well adapted to tropical disturbance. However, as stated in the final rule, the low number of populations and individuals pose a threat to the species by making it susceptible to stochastic events such as hurricanes. Additionally, heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides, which are part of the forest dynamics. A massive landslide in areas where this species grows would not only take out the adult ferns and their offsprings, but their habitats as well. Even a small landslide would provide an opening in the vegetation that would allow other plants (native or non-native, herbaceous or woody) to become established. Moreover, the frequency and severity is expected to increase due to climate change (Hopkinson et al. 2008 (USFWS, 2015).

**Stressor:** Climate change (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (IPCC 2007, Glick et al. 2011). Therefore, shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Numerous plant species in Puerto Rico survived the deforestation that occurred in the Island during the early 1930s. Some species, however, survived that deforestation and are now restricted to forests remnants. Climate change may alter or modify the microclimatic conditions of those remnants where *T. verecunda* occurs. Under this scenario, these populations may be displaced or outcompeted by native or exotic species with wider environmental plasticity (USFWS, 2015).

**Recovery****Reclassification Criteria:**

1. The known populations are placed under protective status (USFWS, 2015).
2. An agreement between the Service and the Puerto Rico Department of Natural Resources (PRDNER) concerning the protection of the three fern species in Commonwealth Forests has been developed and implemented (USFWS, 2015).

3. New populations (the number of which should be determined by appropriate studies) capable of self-perpetuation have been established within protected areas (USFWS, 2013).

**Delisting Criteria:**

The amended delisting criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* are as follows: 1. Existing populations (number populations in parentheses) of *E. Serpens* (2), *P. calderonenses* (3), *T. estremerana* (3), *T. verecunda* (3), *Tinabonensis* (2) and *T. yaucoensis* (2) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and Factor E). 2. Establish or discover new populations (number of populations in parentheses) within the historical range of *E. serpens* (3), *T. inabonensis* (3), *T. yaucoensis* (3), *P. calderonense* (2), *T. estremerana* (2), and *T. verecunda* (2) that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and 3. Threat reduction and management activities have been implemented to a degree that the species is viable for the foreseeable future (addresses Factor A and E) (USFWS, 2019).

**Recovery Actions:**

- Prevent further habitat loss and population decline (USFWS, 1994).
- Continue to gather information on the distribution and abundance of the species (USFWS, 1994).
- Conduct research on habitat requirements, reproductive biology, and ecology of the seven species (USFWS, 1994).
- Establish new populations (USFWS, 1994).
- Refine recovery goals (USFWS, 1994).

***Conservation Measures and Best Management Practices:***

- Conduct a comprehensive status survey of these species to evaluate the abundance and distribution of *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* in Puerto Rico. Surveys should include both traditional and non-traditional sites (USFWS, 2015).
- Once thorough surveys are conducted, a PVA would be needed to determine the number of self-sustainable populations needed to protect and delist these fern species (USFWS, 2015).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species (USFWS, 2015).
- Efforts to protect populations within privately owned lands should be initiated to reduce habitat deterioration and promote sustainable land use practices (USFWS, 2015).
- Develop propagation techniques for *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*, to establish new self-sustainable populations in protected areas (USFWS, 2015).
- Considering all these factors, we recommend the following: • The habitat of the two (2) known populations of *E. serpens* occurring on protected land (i.e., Cerro Punta and Monte Jayuya) need to be fully assessed, and populations enhanced to ensure their resiliency. Specifically, Possley and Lange (2017), and Service biologist O. Monsegur-Rivera recommend a more comprehensive survey that covers a wider area and expands away from the summit of Cerro Punta, a currently very disturbed area where the species was once found. Additionally, three (3) new populations of *E. serpens* should be established within the Toro Negro Commonwealth Forest or a similar protected

habitat (e.g., Monte Guilarte), which genetically represent the known natural populations. Since this is an epiphytic plant, the protection of forest stands that harbor *E. serpens* common host trees, (e.g., *Lyonia Rubiginosa* var. *stahlii*), is also important in order to ensure the species' viability. • For *P. calderonense*, the two (2) known populations within Guilarte Commonwealth Forest should be monitored and enhanced to ensure their resiliency. Also, the population within the private property at Cerrote de Peiuelas needs to be protected through long-term conservation mechanisms (e.g., conservation easements). In order to achieve five viable populations of *P. calderonenses*, two (2) new populations should be established within the Guilarte Commonwealth Forest or areas with similar habitat characteristics and forest plant species communities (e.g., Toro Negro Commonwealth Forest). • The two (2) current *Tectarea estremerana* populations within private properties need to be protected through long-term conservation mechanisms. Also, the population found at the Rio Abajo Commonwealth Forest should be monitored and enhanced to ensure its resiliency. Additionally, two (2) new populations should be established in properties managed for conservation within the species geographic range. • *Thelypteris verecunda* occurs only on three (3) private properties within the northwest region of Puerto Rico. Therefore, all three populations need to be protected through long-term conservation mechanisms, and two (2) new genetically representative populations need to be established on protected land within its geographic range on suitable habitat for the species. • The two (2) known populations of *T. inabonensis* occur within Toro Negro Commonwealth forest. Since this is protected land, we recommend these two populations need to be monitored and enhanced to ensure their resiliency. Additionally, we recommend the establishment of three (3) new populations also on protected land and within its geographic range. • *Thelypteris yaucoensis* occurs on two (2) private properties within Yauco, and possibly, within protected land at Los Tres Picachos. However, if these two populations are not currently protected, they need to be protected through long-term conservation mechanisms. Additionally, three (3) populations should be established within areas already managed for conservation and within the species geographic range, or sites with similar habitat characteristics and forest plant communities.

**ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS**

1. Genetic material from all species should be preserved through long-term spore storage and/or propagation efforts in institutions authorized by the Service. Priority species for this action are *E. serpens*, *P. calderonenses*, and *T. inabonensis* because their taxonomy is not in question. This recovery action should be added to recovery action 33.
2. Establishing new populations outside the current range needs a monitoring and propagation protocol, and pilot studies to ensure appropriate planting sites. To be added to the recovery action 4 (41).
3. Since most agreements and conservation efforts are associated with other Service branches or partner organizations, careful planning for conservation and management needs to be developed and should include partners' education. To be added to recovery action 1 (14).
4. Implement fire and invasive plant species management and control protocols at disturbed areas. This should be added as a new action in the recovery plan (USFWS, 2019).

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## SPECIES ACCOUNT: *Thelypteris yaucoensis* (No common name)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 7/2/1993; Southeast Region (Region 4) (USFWS, 2015)

#### **Physical Description**

A terrestrial fern with an erect, 0.5-mm-thick rhizome, which is bearded at the apex with a tuft of brown, narrowly to broadly lance-attenuate. 5 to 8 mm long scales. The few fronds are 44 to 52 cm long and have lustrous light brown, glabrous, 18- to 22-cm long stipes. The blades are narrowly deltate to oblong. 25 to 31 cm long, 10 to 14 cm broad, acuminate at the apex and truncate at the base. The rachis, costae and costules are more or less stellate-puberulous on both sides. This fern has 13 to 15 pairs of alternate, irregularly linear-oblong pinnae. The pinnae are mostly simple, with 5 to 6 pairs of veins and are all free except for the lowest pairs which are more or less joined. This fern has inframedial to medial sori, which are ciliated with minute forked and 3-branched hairs, and have small indusium often hidden by the sporangia (Proctor 1989). (USFWS, 1994)

#### **Taxonomy**

Not Available

#### **Historical Range**

Not Available

#### **Current Range**

*Thelypteris yaucoensis* is known from Los Tres Picachos in the municipality of Ciales, and from two other private properties in the municipality of Yauco: Pico Rodadero, Sierra Alta and at Rubias Wards. Current population estimates for each location is unclear, however, Proctor (1991) reported 65 individuals for all three sites. Nonetheless, Possley and Lange (2016) re-discovered the species at Pico Rodadero and documented about 59 plants of what seemed to be *T. yaucoensis*. Morphological similarities with *T. sclerophylla* pose taxonomical questions on the identity of *T. yaucoensis* (Possley and Lange 2016, 2017). Currently, tissue samples are being analyzed at the University of Florida (Possley and Lange 2017). The other two localities, Los Tres Picachos and Rubias Ward, have not been visited since 1991 and, therefore, their current status remains unknown. Furthermore, it is unclear if the population of *T. yaucoensis* at Los Tres Picachos lies within the boundaries of the area managed for conservation by the Puerto Rico Department of Natural and Environmental Resources. *Thelypteris inabonensis* is only known from two localities within the Toro Negro Commonwealth Forest: headwaters of Rio Inabón, and Cerro Rosa, where 34 and 12 plants were reported by Proctor (1991), respectively (USFWS 2010). Neither of these populations have been visited since 1991 and, therefore, their current status is unknown. These ferns are known to occur on medium to high elevation mountains (USFWS 2010, USFWS 2015) mostly on sites that exhibit mature vegetation with dense or closed canopies, which often promotes specific microhabitat conditions that are essential for their establishment (e.g., shaded conditions, moisture, humus and mossy substrate, high humidity level and moderate temperatures (USFWS 2010, USFWS 2015)). Therefore, habitat destruction or modification is one of the most conspicuous threats that these fern species may face, not only by individuals directly impacted, but often by changes in microhabitat, which also may favor establishment of exotic plant species (USFWS, 2019).

**Critical Habitat Designated**

Yes;

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

Adult: Not available

**Habitat Type**

Adult: Terrestrial (EPA, 2016)

**Habitat Vegetation or Surface Water Classification**

Adult: Subtropical moist forest (EPA, 2016)

**Geographic or Habitat Restraints or Barriers**

Adult: ~2788 to 3936 ft. elevation (EPA, 2016)

**Environmental Specificity**

Adult: Narrow (inferred from EPA, 2016)

**Habitat Narrative**

Adult: This species grows in humus on steep, shaded rocky banks and ledges in the central mountains with the municipalities of Yauco and Ciales in subtropical moist forest life zone. It occurs between 2788 and 3936 ft. in elevation (EPA, 2016).

***Dispersal/Migration*****Dispersal/Migration Narrative**

Adult: This species relies on abiotic dispersal mechanisms (EPA, 2016).

***Population Information and Trends*****Population Trends:**

Not available

**Species Trends:**

Unknown (USFWS, 2015)

**Resiliency:**

Low (inferred from USFWS, 1994)

**Representation:**

Low (inferred from USFWS, 1994)

**Redundancy:**

Low (inferred from USFWS, 1994)

**Number of Populations:**

3 (USFWS, 1994)

**Population Size:**

65 (USFWS, 1994)

**Population Narrative:**

The specie status is unknown; The status and distribution of *T. yaucoensis* has not been reevaluated since 1995 (USFWS 1995) (USFWS, 2015). *T. yaucoensis* is known from 3 sites, from which approximately 65 individuals have been estimated (Proctor 1991) (USFWS, 1994).

***Threats and Stressors***

**Stressor:** Habitat destruction and modification (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *Thelypteris yaucoensis* is known to occur in Rubias Ward and the summit area of Pico Rodadero, Sierra Alta Ward in Yauco. Currently, Rubias Ward is known for its agricultural practices, the majority of the private lands located at this Ward have active coffee plantations. Although Pico Rodadero is a privately owned land, people have access to this mountain and often go hiking and drive ATVs throughout the property. Thus, the species can be affected by these practices due to habitat destruction (e.g., cattle grazing, agricultural practices, human induced fire). The low number of known individuals (i.e., 65 individuals within these three locations), and the restricted distribution of the species, makes it more susceptible to habitat modification, which could result in the elimination of the populations (USFWS, 2015).

**Stressor:** Limited distribution (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** *T. yaucoensis* is vulnerable to extinction due to low population numbers and restricted distribution. The low number of individuals and limited geographic range may also exacerbate its vulnerability to natural or anthropogenic events such as hurricanes, landslides, low genetic variation, and habitat modification, compromising the continued existence of this species (USFWS1995) (USFWS, 2015).

**Stressor:** Genetic variation (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Given the limited geographic distribution of *T. yaucoensis*, it is highly likely that its genetic variability is low. In rare species like this fern, genetic variation is very important because the loss of genetic variation can reduce the ability of these species to adapt to environmental changes. In addition, it may increase the susceptibility to diseases and pests. This is highlighted

by the fact that these three species show a low number of populations with a low number of individuals (USFWS, 2015).

**Stressor:** Stochastic events (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** As a species endemic to the Caribbean, *T. yaucoensis* should be well adapted to tropical disturbance. However, as stated in the final rule, the low number of populations and individuals pose a threat to the species by making it susceptible to stochastic events such as hurricanes. Additionally, heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides, which are part of the forest dynamics. A massive landslide in areas where this species grows would not only take out the adult ferns and their offsprings, but their habitats as well. Even a small landslide would provide an opening in the vegetation that would allow other plants (native or non-native, herbaceous or woody) to become established. Moreover, the frequency and severity is expected to increase due to climate change (Hopkinson et al. 2008) (USFWS, 2015).

**Stressor:** Climate change (USFWS, 2015)

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (IPCC 2007, Glick et al. 2011). Therefore, shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Numerous plant species in Puerto Rico survived the deforestation that occurred in the Island during the early 1930s. Some species, however, survived that deforestation and are now restricted to forests remnants. Climate change may alter or modify the microclimatic conditions of those remnants where *T. yaucoensis* occurs. Under this scenario, these populations may be displaced or outcompeted by native or exotic species with wider environmental plasticity (USFWS, 2015).

## ***Recovery***

### **Reclassification Criteria:**

1. The known populations are placed under protective status (USFWS, 2015).
2. An agreement between the Service and the Puerto Rico Department of Natural Resources (PRDNER) concerning the protection of the three fern species in Commonwealth Forests has been developed and implemented (USFWS, 2015).
3. New populations (the number of which should be determined by appropriate studies) capable of self-perpetuation have been established within protected areas (USFWS, 2015).

### **Delisting Criteria:**

The amended delisting criteria for *Elaphoglossum serpens*, *Polystichum calderonense*, *Tectaria estremerana*, *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* are as follows: 1. Existing populations (number populations in parentheses) of *E. Serpens* (2), *P.*

calderonenses (3), *T. estremerana* (3), *T. verecunda* (3), *Tinabonensis* (2) and *T. yaucoensis* (2) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and Factor E). 2. Establish or discover new populations (number of populations in parentheses) within the historical range of *E. serpens* (3), *T. inabonensis* (3), *T. yaucoensis* (3), *P. calderonense* (2), *T. estremerana* (2), and *T. verecunda* (2) that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected via a conservation mechanism (addresses Factor A and 3. Threat reduction and management activities have been implemented to a degree that the species is viable for the foreseeable future (addresses Factor A and E) (USFWS, 2019).

**Recovery Actions:**

- Prevent further habitat loss and population decline (USFWS, 1994).
- Continue to gather information on the distribution and abundance of the seven endangered ferns (USFWS, 1994).
- Conduct research on habitat requirements, reproductive biology, and ecology of the seven species (USFWS, 1994).
- Establish new populations (USFWS, 1994).
- Refine recovery goals (USFWS, 1994).

**Conservation Measures and Best Management Practices:**

- Conduct a comprehensive status survey of these species to evaluate the abundance and distribution of *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis* in Puerto Rico. Surveys should include both traditional and non-traditional sites (USFWS, 2015).
- Once thorough surveys are conducted, a PVA would be needed to determine the number of self-sustainable populations needed to protect and delist these fern species (USFWS, 2015).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species (USFWS, 2015).
- Efforts to protect populations within privately owned lands should be initiated to reduce habitat deterioration and promote sustainable land use practices (USFWS, 2015).
- Develop propagation techniques for *Thelypteris inabonensis*, *Thelypteris verecunda*, and *Thelypteris yaucoensis*, to establish new self-sustainable populations in protected areas (USFWS, 2015).
- Considering all these factors, we recommend the following:
  - The habitat of the two (2) known populations of *E. serpens* occurring on protected land (i.e., Cerro Punta and Monte Jayuya) need to be fully assessed, and populations enhanced to ensure their resiliency. Specifically, Possley and Lange (2017), and Service biologist O. Monsegur-Rivera recommend a more comprehensive survey that covers a wider area and expands away from the summit of Cerro Punta, a currently very disturbed area where the species was once found. Additionally, three (3) new populations of *E. serpens* should be established within the Toro Negro Commonwealth Forest or a similar protected habitat (e.g., Monte Guilarte), which genetically represent the known natural populations. Since this is an epiphytic plant, the protection of forest stands that harbor *E. serpens* common host trees, (e.g., *Lyonia Rubiginosa* var. *stahlii*), is also important in order to ensure the species' viability.
  - For *P. calderonense*, the two (2) known populations within Guilarte Commonwealth Forest should be monitored and enhanced to ensure their resiliency. Also, the population within the private property at Cerrote de Peiiuelas needs to be protected through long-term conservation mechanisms (e.g., conservation easements). In order to achieve five viable populations of *P. calderonenses*, two (2) new populations should be established within the Guilarte Commonwealth Forest or areas with

similar habitat characteristics and forest plant species communities (e.g., Toro Negro Commonwealth Forest). • The two (2) current *Tectarea estremerana* populations within private properties need to be protected through long-term conservation mechanisms. Also, the population found at the Rio Abajo Commonwealth Forest should be monitored and enhanced to ensure its resiliency. Additionally, two (2) new populations should be established in properties managed for conservation within the species geographic range. • *Thelypteris verecunda* occurs only on three (3) private properties within the northwest region of Puerto Rico. Therefore, all three populations need to be protected through long-term conservation mechanisms, and two (2) new genetically representative populations need to be established on protected land within its geographic range on suitable habitat for the species. • The two (2) known populations of *T. inabonensis* occur within Toro Negro Commonwealth forest. Since this is protected land, we recommend these two populations need to be monitored and enhanced to ensure their resiliency. Additionally, we recommend the establishment of three (3) new populations also on protected land and within its geographic range. • *Thelypteris yaucoensis* occurs on two (2) private properties within Yauco, and possibly, within protected land at Los Tres Picachos. However, if these two populations are not currently protected, they need to be protected through long-term conservation mechanisms. Additionally, three (3) populations should be established within areas already managed for conservation and within the species geographic range, or sites with similar habitat characteristics and forest plant communities.

ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS

1. Genetic material from all species should be preserved through long-term spore storage and/or propagation efforts in institutions authorized by the Service. Priority species for this action are *E. serpens*, *P. calderonenses*, and *T. inabonensis* because their taxonomy is not in question. This recovery action should be added to recovery action 33.
2. Establishing new populations outside the current range needs a monitoring and propagation protocol, and pilot studies to ensure appropriate planting sites. To be added to the recovery action 4 (41).
3. Since most agreements and conservation efforts are associated with other Service branches or partner organizations, careful planning for conservation and management needs to be developed and should include partners' education. To be added to recovery action 1 (14).
4. Implement fire and invasive plant species management and control protocols at disturbed areas. This should be added as a new action in the recovery plan (USFWS, 2019).

## References

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## SPECIES ACCOUNT: *Trichomanes punctatum* ssp. *floridanum* (Florida bristle fern)

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### *Species Taxonomic and Listing Information*

**Listing Status:** Endangered; 11/05/2015; Southeast Region (R4) (USFWS, 2016)

### Physical Description

The Florida bristle fern is a very small, mat-forming fern, superficially resembling some liverwort species. Wunderlin and Hansen (2000, pp. 153-154) described it as “Stem long-creeping, mat forming, the trichomes (hairlike or bristlelike outgrowth) brownish black, of 2 types, 2-celled glandular and elongate rhizoidlike ones; roots absent. Leaves separated, the petiole 0.1-2 centimeters (cm) long, usually shorter than the blade, pubescent above and below with trichomes like those of the stem but shorter, with stellate (star-shaped) trichomes few and distal on the winged upper part, the blade flabellate (fan-shaped), round, narrowly oblanceolate to nearly linear, entire or irregularly lobed at the apex, 0.5-2 cm long, 0.2-1.1 cm wide, the midrib wanting or less than ½ the blade length, the apex rounded to obtuse, the base narrowly cuneate (wedge-shaped), the margin entire to irregularly and flabellately lobed, lobes oblong and blunt to obscurely deltoid, frequently resembling proliferous outgrowths distally, with marginal black stellate trichomes, with 2-celled glandular trichomes on the veins, false veins few, the true veins not enlarged at their apex. Involucres (a cup-shaped structure which houses the spore-bearing organs) 1.5-2 millimeters (mm) long, 1-6 at the blade apex, immersed for ½ or more of their length to fully so, the lips distinct from the blade tissue, inconspicuously dark-margined, the receptacle included or exerted to less than about ½ the involucre length.”

### Taxonomy

The genus *Trichomanes* is mostly tropical, with about 300 species. A few species grow in temperate regions. When Florida bristle fern was first discovered in Miami-Dade County it was referred to as *T. sphenoides* Kunze (Eaton 1906, p. 460; Small 1913, p. 4). Underwood (1906, p. 201) treated Miami-Dade plants as *Didymoglossum sphenoides* (Kunze) Presl. John Kunkel Small later determined the plants in Miami-Dade County to be *T. punctatum* (Small 1918a, p. 6; Small 1918b, p. 4; Small 1931, p. 35). After it was found in Sumter County in 1936, John Kunkel Small referred the Miami-Dade plants to *T. punctatum* and the Sumter plants to *T. sphenoides* (Small 1938, pp. 48-50). This treatment was followed by Wherry (1964, p. 232). The current taxonomy of *Trichomanes punctatum* is the result of monographic revision of *Trichomanes* sections *Didymoglossum* and *Microgonium* by Wessels Boer (1962, pp. 300-301). We have carefully reviewed the available taxonomic information to reach the conclusion that the subspecies is a valid taxon.

### Historical Range

The historical range of Florida bristle fern included southern (Miami-Dade County) and central (Sumter County) Florida. In Miami-Dade County it occurred historically in at least 12 hammocks (Castellow, Cox, Fuchs, Hattie Bauer, Meissner, Modello area, Nixon-Lewis, Ross, Royal Palm, Shields, Silver Palm, Snapper Creek area) (Gann et al. 2002, pp. 552-554). The range extended from Royal Palm Hammock (now in Everglades National Park [ENP]) at its southern limit, north to at least Snapper Creek, and possibly further north into the Miami area (Gann et al. 2002, pp. 552-554). This is a range of at least 45 kilometers (km) (28 miles [mi]).

**Current Range**

There are currently five, and possibly six, extant occurrences of Florida bristle fern (Gann et al. 2002, pp. 552-554), four in Miami-Dade County and two in Sumter County (Table 1). The Sumter County occurrences are approximately 400 km (249 mi) north of those in Miami-Dade County. In Miami-Dade County, Florida bristle fern is known from Meissner Hammock<sup>1</sup> in two solution holes (K. Bradley, pers. comm. 2009), from Fuchs Hammock Preserve<sup>2</sup> in three solution holes, and from Castellow Hammock Park<sup>3</sup> in two large solution holes and several smaller holes and rocky outcroppings (J. Possley, pers. comm. 2008). Fuchs and Meissner Hammocks are immediately adjacent to each other, and Castellow Hammock Park is 10.5 km (6.5 mi) to the northeast. During 2011, eight small patches of Florida bristle fern were re-discovered at Hattie Bauer Hammock<sup>4</sup>. Seven of the these patches occurred within a single solution hole, the eighth patch was found a few meters away from the hole J. Possley (pers. comm. 2011). Hattie Bauer Hammock is 2.5 miles south of Castellow Hammock and approximately 5 miles northeast of Fuchs and Meissner Hammocks. In Sumter County, it is known from one colony in the Withlacoochee State Forest's Jumper Creek Tract<sup>5</sup>, north of Wahoo. Another occurrence consisting of two colonies on private land just south of the State Forest<sup>6</sup> may be extirpated.

**Critical Habitat Designated**

Yes;

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

Adult: Sexual and asexual

**Breeding Season**

Adult: Spores have been recorded in October (J. Possley, pers. comm. 2007), but plants probably produce spores during much of the summer wet season.

**Key Resources Needed for Breeding**

Adult: Unknown

**Reproduction Narrative**

Adult: Little is known about the life history of this taxon, or for members of the genus in general. Like all ferns, Florida bristle fern has two life history stages, a gametophyte stage and a sporophyte stage. All populations that have been reported have been in the sporophyte stage. The initial stage, after a spore germinates, is the gametophyte stage. The gametophyte contains separate sperm and egg producing structures. In the presence of water or moisture, sperm reach the eggs for fertilization. Fertilized eggs, under the proper conditions, develop into sporophytes – the typical form most ferns are observed in. The sporophytes produce spores which in turn can germinate to produce new gametophytes (Nelson 2000, pp. 17-19). Reproduction may also occur in two other ways. Plants may reproduce by division, when rhizomes break, forming clones of the parent plant. They may also reproduce with the production of gemmae, propagules produced by gametophytes, which can grow into new gametophytes of the same genotype (Hill 2003, p. 12). Spores have been recorded in October (J.

Possley, pers. comm. 2007), but plants probably produce spores during much of the summer wet season. During the dry season, sporophytes have been observed to desiccate, and probably do not produce spores. For Florida bristle fern, the reproductive requirements, such as moisture levels, needed for each stage of its life history are unknown. Data are needed on longevity, growth rates, recruitment rates, dispersal methods, and genetic variation.

**Habitat Type**

Adult: Tropical hardwood forest

**Habitat Narrative**

Adult: Florida bristle fern is always associated with shaded limestone outcrops. Plants usually grow on bare limestone, but are occasionally found on tree roots growing on limestone. In Miami-Dade County, it has been found exclusively in oolitic (composed of minute rounded concretions resembling fish eggs) limestone solution holes and rocky outcrops in rockland hammocks. Solution holes are formed by dissolution of subsurface limestone followed by a collapse above (Snyder et al. 1990, p. 236). Solution holes vary in size, from shallow holes less than 0.5 meter (m) (1.6 feet [ft]) deep to those that cover over 100 m<sup>2</sup> (1,076 ft<sup>2</sup>) and are several meters deep. The bottoms of most solution holes are filled with deep organic soils. Deeper solution holes penetrate the water table and have (at least historically) standing water for part of the year. Humidity levels are higher in and around the solution holes because of standing water and moisture retained in the organic soils. The canopy cover is typically very dense where Florida bristle fern occurs, and consists of a mix of temperate and tropical hardwood trees including lancewood (*Ocotea coriacea*), pigeon plum (*Coccoloba diversifolia*), live oak (*Quercus virginiana*), paradise tree (*Simarouba glauca*), strangler fig (*Ficus aurea*), and mastic (*Sideroxylon foetidissimum*) (K. Bradley, pers. comm. 2007). Many tropical, epipetric plant species are associated with solution holes in rockland hammocks. Soils at the Miami-Dade County sites are classified as Matecumbe Muck (<http://www.fgdl.org/>). In Sumter County, the plants occur in a mesic/hydric hammock on limestone boulders 1 - 2 m (3.3 - 6.6 ft) tall, under a canopy of live oak, cabbage palm (*Sabal palmetto*), and American hornbeam (*Carpinus caroliniana*) (C. Werner, pers. comm. 2007). Florida bristle fern grows on boulders with tall, horizontal faces with other rare fern species (e.g., hemlock spleenwort [*Asplenium cristatum*], and widespread polypody [*Pecluma dispersa*]). The hammocks where it has been found are surrounded by a mosaic of wetlands. Soils at the Sumter County station are classified as Mabel Fine Sand, bouldery subsurface (<http://www.fgdl.org/>).

***Dispersal/Migration*****Motility/Mobility**

Adult: Sessile

**Dispersal**

Adult: Unknown

**Dispersal/Migration Narrative**

Adult: No information

***Population Information and Trends***

**Population Trends:**

declining

**Species Trends:**

declining (NatureServe 2010, pp.1-2)

**Number of Populations:**

Miami-Dade County: 4 sites (colonies); Sumter County: 1 colony

**Population Size:**

<1000 plants

**Population Narrative:**

Because Florida bristle fern grows in dense mats and is rhizomatous, it is difficult, if not impossible, to accurately count individual plants. This difficulty has been encountered in other *Trichomanes* species, such as Appalachian bristle fern (*Trichomanes boscianum*) (Hill 2003, p. 11). In Miami-Dade County the taxon occurs at four sites in eight solution holes and several smaller holes and rocky outcroppings (J. Possley, pers. comm. 2008, 2011). Possley has estimated that individual colonies cover from 30 cm<sup>2</sup> (4.7 inches<sup>2</sup> [in]) to a maximum of 400 cm<sup>2</sup> (62 in<sup>2</sup>) on the walls of solution holes. The total area covered by the colonies at the eight solution holes is roughly 1620 cm<sup>2</sup> [251.1 in<sup>2</sup>]. There are probably less than 500 total plants, and many plants may be genetically identical, since new plants can arise from broken rhizomes (Possley, pers. comm. 2011). In Sumter County, the single small colony grows on five or six boulders and covers approximately 0.3 m<sup>2</sup> (3.0 ft<sup>2</sup>) (C. Werner, pers. comm. 2007). There are probably fewer than 1,000 total plants in existence, but this may be a large overestimate of the actual number (K. Bradley, pers. comm. 2007).

**Threats and Stressors**

**Stressor:** Regional drainage

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Impacts from regional drainage in Miami-Dade County are severe and currently occurring. Regional drainage in remaining habitat has probably been a stressor that has contributed to extirpations and population declines (Nauman 1986, p. 182). Resulting drops in ambient humidity in the taxon's habitat may limit reproduction and health of populations over the long-term. Such changes in humidity may cause extirpations or make plants more vulnerable to other stressors (e.g., periodic long-term droughts, hurricanes).

**Stressor:** Agricultural conversion and development

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Agricultural conversion and development are currently occurring in Sumter County, placing any undocumented occurrences and suitable habitat at risk. Since a full survey of suitable habitats for Florida bristle fern has never been conducted in Sumter County, we cannot

determine the extent of losses of this species due to habitat destruction and modification nor the magnitude and immediacy of current threats.

**Stressor:** Invasive nonnative plants

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Invasive exotic plants are also a threat, but may be reduced on public lands due to active programs by Miami-Dade County and the State.

**Stressor:** Climate change

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Climatic changes, including sea level rise, are future, long-term threats that are expected to impact habitat and ultimately reduce the extent of available habitat in Miami-Dade County.

**Stressor:** Stochastic events

**Exposure:**

**Response:**

**Consequence:**

**Narrative:** Because there are few occurrences, populations contain few plants, and genetic variability is low, the species is inherently at risk due to stochastic events (Matthies et al. 2004, pp. 481-488). Stochastic events are expected to exacerbate the impacts of regional drainage and subsequent drops in humidity and cause extirpations. Droughts, tropical storms, and hurricanes are threats. Since few occurrences remain, the entire taxon is threatened with extinction during these events.

## ***Recovery***

### **Reclassification Criteria:**

Recovery Priority Number: 6 (USFWS, 2018)

### **Recovery Actions:**

- Control invasive nonnative plants.
- Reintroduce to historic locations through outplantings.
- Augment existing occurrences through outplantings.
- Collect, cultivate, and maintain of genetic stock ex situ for reintroduction and augmentation.
- Refine ex situ cultivation methods.
- Conduct status surveys at all known, current, and historic locations where suitable habitat remains.
- Restore canopy cover (with shade cloth if needed) over existing colonies after hurricanes or other events cause loss of canopy.
- Promote a higher regional water table on the Miami Rock Ridge.
- Protect habitats from public use.

- Explore the feasibility of pumping water into solution holes that support rare ferns to increase water and humidity levels.
- Explore the potential benefits of watering colonies during extended drought periods.
- Search for new occurrences and all potential suitable habitat in and around Sumter County.
- Search for occurrences in historically occupied areas in Miami-Dade County
- Conduct long-term monitoring of all occurrences.
- Establish a monitoring program at Withlacoochee State Forest.
- Initiate life-history and genetic studies, specifically on longevity, growth rates, recruitment rates, reproductive requirements, dispersal methods, and genetic variation.
- Assess the extent to which fungus may be a threat to the species in the wild.
- Initial recovery actions for the Florida bristle fern will primarily focus on protection of the existing known populations and their habitat and monitoring of these sites. The Florida bristle fern requires multiple (redundancy), self-sustaining (resiliency) populations distributed across its gradient of genetic and ecological diversity (representation). At this time, we do not fully understand these parameters. Therefore, recovery actions to further define those parameters include:
  - Conduct or continue surveys for new populations of the Florida bristle fern.
  - Continue to monitor known Florida bristle fern plants and habitat conditions. This includes monitoring a) the health and numbers of populations, b) microhabitat conditions of humidity (moisture), temperature, hydrology, and substrate, and c) surrounding forest vegetation where sinkholes and limestone outcroppings occur (canopy cover, shade and protection).
  - Prevent damage and loss of existing hammock habitats (primarily from invasive vegetation); maintain the health and vegetative diversity of mixed wetland tropical hardwood system.
  - Conduct or continue research to address a) methods of propagation and reintroduction, and b) spore dispersal and conditions needed for reproduction (such as adequate moisture levels).
  - Enhance populations through captive propagation and reintroduction.
  - Identify project types and locations that may need special attention (timber; loss of surrounding forest causing edge effect to hammock microclimate).
  - Continue to work cooperatively with federal, state, and local government agencies, universities, private landowners, the public, and other recovery partners to restore and protect forested hammock habitat and the Florida bristle fern metapopulations.
  - Perform outreach and education on the hammock environment and the Florida bristle fern (USFWS, 2018).

***Conservation Measures and Best Management Practices:***

- Control invasive nonnative plants.
- Reintroduce to historic locations through outplantings.
- Augment existing occurrences through outplantings.
- Collect, cultivate, and maintain of genetic stock ex situ for reintroduction and augmentation.
- Refine ex situ cultivation methods.
- Conduct status surveys at all known, current, and historic locations where suitable habitat remains.
- Restore canopy cover (with shade cloth if needed) over existing colonies after hurricanes or other events cause loss of canopy.
- Promote a higher regional water table on the Miami Rock Ridge.
- Protect habitats from public use.
- Explore the feasibility of pumping water into solution holes that support rare ferns to increase water and humidity levels.
- Explore the potential benefits of watering colonies during extended drought periods.

- Search for new occurrences and all potential suitable habitat in and around Sumter County.
- Search for occurrences in historically occupied areas in Miami-Dade County
- Conduct long-term monitoring of all occurrences.
- Establish a monitoring program at Withlacoochee State Forest.
- Initiate life-history and genetic studies, specifically on longevity, growth rates, recruitment rates, reproductive requirements, dispersal methods, and genetic variation.

## References

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Endangered Species Status for *Trichomanes punctatum* ssp. *floridanum* (Florida Bristle Fern)

Proposed rule

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