

Recovery Outline for Hawai`i Island

Scientific Name/ Common name

PLANTS

Bidens hillebrandiana ssp. *hillebrandiana*/ ko`oko`olau

Bidens micrantha ssp. *ctenophylla*/ ko`oko`olau

Cyanea marksii/ hāhā

Cyanea tritomantha/ `akū

Cyrtandra nanawaleensis/ ha`iwale

Cyrtandra wagneri/ ha`iwale

Phyllostegia floribunda/ no common name

Pittosporum hawaiiense/ hō`awa, hā`awa

Platydesma remyi/ no common name

Pritchardia lanigera/ loulu

Schiedea diffusa ssp. *macraei*/ no common name

Schiedea hawaiiensis/ no common name

Stenogyne cranwelliae/ no common name

ANIMALS

Drosophila digressa/ picture-wing fly

Vetericaris chaceorum/ anchialine pool shrimp



Cyanea tritomantha (USFWS)



Bidens micrantha ssp. *ctenophylla* (USFWS)



Vetericaris chaceorum (T. Sakihara)



Drosophila digressa (K. Magnacca)

Listing Status and Date: Endangered; October 29, 2013 (78 Federal Register 64638)

Lead Regional Office: U.S. Fish and Wildlife Service, Interior Region 12

Lead Field Office: Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Honolulu, Hawai'i 96850
808-792-9400

Purpose of the Recovery Outline: This document lays out a preliminary course of action for the survival and recovery of 13 endangered plant and 2 endangered animal species (hereafter 15 newly species) listed in 2013 (USFWS 2013) under the Endangered Species Act (ESA) of 1973, as amended (16 USC 1531 *et seq.*). Recovery outlines include background information about the species, previous conservation efforts, and a list of recovery actions needed to meet recovery criteria. This recovery outline will address the recovery needs of the 15 species. To achieve recovery of these species, the recovery plan will designate management units encompassing all or portions of the ecosystems on which the species depend. Recovery actions within these management units will be prioritized based on criteria developed within the Pacific Islands Fish and Wildlife Office as available funding to manage all units or threats simultaneously is limited.

This outline serves as interim guidance directing recovery efforts and informing consultation and permitting activities until a comprehensive recovery plan has been completed. Recovery outlines are intended primarily for internal use by the U.S. Fish and Wildlife Service (Service); formal public participation will be invited with the release of the draft recovery plan and the Service will consider any new information or comments from the public in response to this outline during the drafting of the recovery plan. For more information on Federal recovery efforts for the 15 recently listed species, or to provide comments, interested parties may contact the lead field office for these species at the above address and telephone number.

Scope of Recovery and Available Information: The scope of this effort is at the island level. This recovery outline is based on best available scientific data contained in the proposed and final listing and critical habitat rules for the 15 species endemic to Hawai'i Island and the species for which critical habitat was recently designated or revised (USFWS 2012, 2013, 2018). Based on the best available data at the time of the listing decision, critical habitat was delineated for only one of the listed species, *Bidens micrantha* ssp. *ctenophylla* (USFWS 2012). For the remaining 14 species, the analysis necessary to designate critical habitat essential to the species' conservation could not be completed (USFWS 2013). The final critical habitat designation for *Bidens micrantha* ssp. *ctenophylla* published on August 21, 2018 (USFWS 2018). Little information beyond current status and existing threats is available for most of the 15 recently listed species. Additional research on distribution and range, especially with regard to the

impacts of climate change is needed to fully understand what is required for the recovery of these species. Uncertainties associated with the specific habitat needs and biology of the 15 species will be resolved, to the extent possible, through the recovery implementation process, and the recovery plan may need to be periodically updated. The recovery strategy will include recommendations to address these uncertainties with specific habitat needs and the biology of the species, and will contribute to adaptive management.

I. Overview

A. BIOLOGICAL ASSESSMENT

1. Species Description and Life History

Species descriptions and life history information are contained in the final listing decision ([USFWS 2013](#)) and the proposed listing rule ([USFWS 2012](#)) for the 15 recently listed species.

2. Historical and Current Population Status

The historical and current population status of these species also are contained in the final listing decision (USFWS 2013) and the proposed listing rule (USFWS 2012) for the 15 recently listed species (Table 1) as are the species' current distribution (Appendix 1).

3. Habitat Description and Landownership

The 13 plants, 1 insect (picture-wing fly), and 1 crustacean (anchialine pool shrimp) are known from 10 habitats found on the island of Hawai'i: anchialine pool, coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, dry cliff, and wet cliff (see Table 1 and Map 2 - Island of Hawai'i Species Habitats). These species and their habitats occur on Federal, State, County, and private lands (USFWS 2012, 2018).

4. Summary Biological Assessment

Identified threats to these species affect their status throughout their entire range. Active management (*i.e.*, habitat protection and predator control) on other Hawaiian Islands has shown that the potential for recovery is high if major threats are controlled.

In Hawai'i, active management of threats, such as ungulates and invasive nonnative plants, has been successful across many habitats. As an example of active management, an ungulate exclosure on the Island of Hawai'i demonstrated that eliminating goat browsing via fencing resulted in a rapid recovery in height, growth and numbers of vegetative re-sprouts of

Acacia koa (koa) (Spatz and Mueller-Dombois 1973). After the removal of nonnative grazing animals at Pu'u Wa'awa'a in 1985, *Acacia koa* and *Metrosideros polymorpha* (ōhi'a) seedlings germinated by the thousands (Hawai'i Department of Land and Natural Resources 2003). Loope *et al.* (1991) found that native plant cover increased from 6 to 95 percent after excluding pigs from a montane bog on Maui. In Hawai'i Volcanoes National Park, herbicide control of the invasive grass *Cenchrus clandestinus* (kikuyu grass) decreased cover from nearly 100 percent to less than 10 percent, and most native species survived the treatment and often proliferated (Gardner and Kageler 1983). Cabin *et al.* (2000) documented an increase in native seedlings and ground cover in a dry forest after removal of *Cenchrus setaceus* (fountain grass). Removal of *Morella faya* (faya tree) by girdling resulted in better recovery of native plant species, as measured by a more diverse suite of species and a smaller increase in nonnative plant species when compared to clear cut areas (Loh and Daehler 2007, 2008).

The management of additional threats, such as rodents and slugs, is possible but will require additional research to determine the most efficient and effective control methods and may require the registration of new pesticides for use in conservation areas. Rodent control occurs at different scales and with different tools across the Hawaiian Islands and information sharing is key for refining methods to enhance conservation (Sprague *et al.* 2018). Pesticides to control slugs are available for use and have been shown to decrease slugs in mesic forests (OANRP 2017); however, there has been little documentation of the response of rare plants to reductions in slugs. Propagation and reintroduction will also be needed for many species to increase the number of individuals and/or populations.

Systematic surveys are needed to assess the current distribution of these species and their habitat requirements, as in some situations, recovery areas may need to be expanded beyond current and historical distributions. Modeling based on species requirements and known distributions will assist in selecting possible additional areas needed for recovery. Models incorporating climate change projections need to be developed to map potential suitable habitat and distribution.

The Pacific Islands Fish and Wildlife Office's Strategic Plan (USFWS 2011a) identifies priority ecosystem conservation areas (or priority landscapes) on Hawai'i. Priority landscapes encompass key native ecosystems that, when appropriately managed, may provide for the long-term viability of entire native biotic communities, and thus, multiple native species. These areas were delineated based in part on designated critical habitat, forest bird recovery areas, essential plant habitats, information in the Recovery Plan for Hawaiian Waterbirds (USFWS 2011b), and other surveys and conservation planning documents. The priority landscape map for the island group will be used to help develop the Hawai'i recovery plan and its conservation strategy.

Resiliency, Representation, and Redundancy:

Representation, Resiliency, and Redundancy (the "3Rs") comprise key characteristics that collectively contribute to a species' ability to sustain secure populations over the long term. When combined across populations, they measure the health of the species as a whole. The more we can identify and break down the constituent elements contributing to resiliency,

representation, and redundancy, the better we can understand what contributes to, and is necessary for, the long-term health of a species. Representation contributes to the adaptability and evolutionary capacity of a species over time, to accommodate long term issues like climate change. Resiliency speaks to an individual population's ability to tolerate environmental and demographic stochasticity, such as fluctuations in temperature or genetic drift. Redundancy contributes to the ability of population types to withstand catastrophic events (hurricanes, wildfires, etc.). The 3Rs are interconnected and overlapping. For example populations must be resilient in order to contribute to redundancy or representation. Likewise, redundant populations within a representative genotype or ecological setting contribute to the maintenance of the representation contributing to the species' adaptive and evolutionary capacity. As with all things biological, evaluation of the 3Rs for any species must be considered in the context of the species' life history and ecology.

- **Low to Moderate Resiliency**

Species with populations comprised of a small number of individuals are at a higher risk of extinction than those with a larger number of individuals. The former populations have lower resiliency when compared to the latter populations. Because of the low number of individuals, each population is more likely to be affected by stochastic events, low gene flow and inbreeding depression, hybridization, loss of host plants, or lack of regeneration. Each of the 15 recently listed species are comprised of small populations and are vulnerable to future extirpation due to stochastic events, low gene flow and inbreeding depression, hybridization, loss of host plants, or lack of regeneration.

- **Low to Moderate Redundancy**

Species with populations comprised of a small number of populations with a limited geographic range are at a higher risk of extinction than those with a larger number of populations distributed over a larger geographic range. The former populations have lower redundancy when compared to the latter populations. Overall, redundancy is low to moderate for the 15 species because of their endemism, small number of populations, low to moderate resiliency of populations, and restricted habitats.

Species which occupy limited areas, such as *Drosophila digressa*, which is known from only two locations, are less able to recover from threats or perturbations that might otherwise have a relatively minor effect on widely-distributed species. For example, the reduced availability of host trees or an increase in predation of the picture-wing fly adults that a widely-distributed species could tolerate would result in a significant decrease in survivorship or reproduction of a species with limited distribution. The limited distribution of this species magnifies the severity of the impact of the other threats discussed in the final listing decision (USFWS 2013).

- **Low to Moderate Representation**

Species that occupy a limited number of niches or have low gene diversity are at a higher risk of extinction than those occupying more niches or with higher gene diversity. The former populations have lower representation when compared to the latter populations. Low diversity is maintained within the 15 species, with a few plants (*Bidens hillebrandiana* ssp. *hillebrandiana*, *Cyrtandra wagneri*, *Schiedea diffusa* ssp. *macraei*, and *S. hawaiiensis*), the picture-wing fly, and anchialine pool shrimp restricted to either 1 or 2 populations on a single island. Deforestation, invasive species, and effects due to climate change have contributed to habitat loss and fragmentation and resulted in limited variation in habitats for the 15 species. Overall, representation is low to moderate for the 15 recently listed species based on their limited geographic and ecological range and low to moderate resiliency of populations. Therefore, we would expect these species to be particularly vulnerable to climate change and subsequent impacts to their habitats.

Under current conditions, many of these species are so rare in the wild that they are at high risk of extirpation or even extinction from various catastrophic events, such as hurricanes or landslides. Therefore, improving resilience of populations and redundancy in these species through the establishment of multiple robust populations is a key component of recovery.

Table 1. Current status and distribution of 13 plant and 2 animal species found on the island of Hawai`i, including the number of populations (# pops), number of individuals (# inds), and the habitat types used or occupied.

Species	# pops	# inds	Habitat Types									
			CO	LD	LM	LW	MD	MM	MW	DC	WC	AP
PLANTS												
<i>Bidens hillebrandiana</i> ssp. <i>hillebrandiana</i>	2	40	X								X	
<i>Bidens micrantha</i> ssp. <i>ctenophylla</i>	6	1,000		X								
<i>Cyanea marksii</i>	3	27				X			X			
<i>Cyanea tritomantha</i>	16	400				X			X		X	
<i>Cyrtandra nanawaleensis</i>	5	160				X						
<i>Cyrtandra wagneri</i>	1	8				X						
<i>Phyllostegia floribunda</i>	12	100				X		X	X			
<i>Pittosporum hawaiiense</i>	14	175			X			X	X			
<i>Platydesma remyi</i>	8	40				X			X			
<i>Pritchardia lanigera</i>	3	225			X	X			X		X	
<i>Schiedea diffusa</i> ssp. <i>macraei</i>	1	1							X			
<i>Schiedea hawaiiensis</i>	1	40					X					
<i>Stenogyne cranwelliae</i>	6	160							X		X	
ANIMALS												
<i>Drosophila digressa</i>	2	Unknown			X			X	X			
<i>Vetericaris chaceorum</i>	2	Unknown										X

CO = Coastal, LD = Lowland Dry Forest, LM = Lowland Mesic Forest, LW – Lowland Wet Forest, MD = Montane Dry Forest, MM = Montane Mesic Forest, DC = Dry Cliff, WC = Wet Cliff, AP = Anchialine Pools.

B. THREATS ASSESSMENT

1. Listing Factors/Primary Threats to the Species

As identified in the final listing rule (USFWS 2013), the primary threats to the 15 recently listed species and their habitats are habitat loss and degradation, invasive plant species; predation or herbivory by nonnative feral ungulates (*e.g.*, pigs, goats), rats, snails, and slugs; wildfire; stochastic events; demographic and genetic consequences of small populations; and effects of climate change (Table 2). With the exception of stochastic events and climate change, these threats can mostly be addressed by ecosystem-level management. Recent volcanic eruptions and associated lava flows from Kilauea Volcano from May to August 2018 have threatened key populations of *Cyrtandra nanawaleensis* (DOFAW 2018). Predation by nonnative wasps and nonnative ants, loss of host plants (*Charpentiera* spp.), and competition for host plants with nonnative tipulid flies also are threats to *Drosophila digressa*. In addition, recreational vehicles, sedimentation, and the intentional dumping of trash and the introduction of nonnative fish into the pools that support the anchialine pool shrimp are serious threats to this species. A description of each threat is presented in the final listing rule (USFWS 2013) and each is classified according to the five listing/delisting factors identified in section 4 of the ESA.

2. Summary Threats Assessment

No new threats to the 15 species have been identified since the final listing rule was published (Table 2) and all threats will be addressed in the recovery plan.

Our analyses includes consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of meteorological conditions (*e.g.*, temperature, precipitation) in a particular region over time, with 30 years being a typical period, although shorter or longer periods also may be used (IPCC 2007). The term “climate change” refers to a change in the mean or variability of one or more measures of climate that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Changes in climate can have direct or indirect effects on species and the effects can be positive, neutral, or negative and may change over time, depending on the species and other factors, such as potential interaction of climate and other variables (*e.g.*, habitat fragmentation) (IPCC 2007, pp. 8–14 and 18–19). In our analyses, we used expert judgment to weigh relevant information, including uncertainty, in considering how various aspects of climate change threaten the recovery of the species herein.

The recovery plan will comprehensively address the 15 listed species endemic to Hawai'i Island, most of which are habitat specialists, have small ranges, or have limited dispersal abilities or opportunities. Together these traits make these species vulnerable to climate change (Fortini *et al.* 2013). Several species are currently undergoing range contractions consistent with

warming temperatures; thus it will be important to consider climate change as part of the threat analyses for the covered species. Applying climate envelope modeling, those that predict the distribution of a species using environmental data such as precipitation and temperature, and other tools to recovery planning will identify climate refugia and dispersal corridors between current and future habitat. This information will help identify management priorities for areas necessary for recovery in a warming climate.

Table 2. Summary of the habitats used by and the threats affecting the 15 listed species endemic to Hawai'i Island as well as each species recovery priority number (see below). Factor A = The present or threatened destruction, modification, or curtailment of the species habitat or range. Factor B = Overutilization for commercial, recreational, scientific, or educational purposes. Factor C = Disease or predation. Factor D = Inadequacy of existing regulatory mechanisms. Factor E = Other natural or manmade factors affecting the species continued existence.

Species	Habitats	Recovery Priority Number	Factor A					Factor B	Factor C				Factor D	Factor E	
			Agriculture and urban development	Ungulates	Nonnative plants	Fire	Stochastic events		Disease	Predation / herbivory by ungulates	Predation / herbivory by other NN vertebrates	Predation / herbivory by NN invertebrates		Inadequate existing regulatory mechanisms	Other species-specific threats
PLANTS															
<i>Bidens hillebrandiana</i> ssp. <i>hillebrandiana</i>	CO, DC	6		P, G	X		H, RF, L, HS, E			P, G	R		X	LN	Pt
<i>Bidens micrantha</i> ssp. <i>ctenophylla</i>	LD	3	X	P, G	X	X	H, DR			P, G	R		X	HY	Pt
<i>Cyanea marksii</i>	LW, MW	5		P, C, M	X		H, RF, L			P, C, MS	R	S	X	LN	Pt
<i>Cyanea tritomantha</i>	LW, MW, WC.	5		P, C	X		H, TF			P, C	R	S	X	NR	Pt
<i>Cyrtandra nanawaleensis</i>	LW	5		P	X		H, V			P	R	S	X	HY	Pt
<i>Cyrtandra wagneri</i>	LW	5		P	X		H, HR, E			P	R	S	X	LN, HY	Pt
<i>Phyllostegia floribunda</i>	LW, MM, MW.	5		P	X	X	H			P			X		Pt

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Species	Habitats	Recovery Priority Number	Factor A					Factor B	Factor C				Factor D	Factor E	
			Agriculture and urban development	Ungulates	Nonnative plants	Fire	Stochastic events	Over-utilization	Disease	Predation / herbivory by ungulates	Predation / herbivory by other NN vertebrates	Predation / herbivory by NN invertebrates	Inadequate existing regulatory mechanisms	Other species-specific threats	Climate Change
<i>Pittosporum hawaiiense</i>	LM, MM, MW.	2		P, C, M	X		H			P, C, MS	R		X	NR	Pt
<i>Platydesma remyi</i>	LW, MW	5		P	X		H			P			X	LN, NR	Pt
<i>Pritchardia lanigera</i>	LM, LW, MW, WC.	2		P, G, M	X		H	X		P, G, MS	R	LH, B	X	NR	Pt
<i>Schiedea diffusa</i> ssp. <i>macraei</i>	MW	6		P, C	X		H			P, C	R		X	LN	Pt
<i>Schiedea hawaiiensis</i>	MD	5		P, G, SH, M.	X	X	H, DR			P, G, DS, MS.	R		X	LN	Pt
<i>Stenogyne cranwelliae</i>	MW, WC	5		P	X		H			P	R	S	X		Pt
ANIMALS															
<i>Drosophila digressa</i>	LM, MM, MW.	5		P, G, C, M.	X	X	H, DR					W, A	X	LN, HL, F	Pt
<i>Vetericaris chaceorum</i>	AP	5		G, C									X	RV, SD, D	Pt

Habitats: AP = Anchialine Pools, CO = Coastal, LD = Lowland Dry Forest, LM = Lowland Mesic Forest, LW = Lowland Wet Forest, MD = Montane Dry Forest, MM = Montane Mesic Forest, MW = Montane Wet Forest, DC = Dry Cliff, WC = Wet Cliff

A = Ants, B = Beetles, C = Cattle, D = Dumping (non-native fish and trash), DR = Drought, DS = Domestic Sheep, E = Erosion, F = Flies, G = Goats, H = Hurricanes, HL = Host Loss, HR = Heavy Rain, HS = High Surf, HY = Hybridization, L = Landslides, LH = Leafhoppers, MS = Mouflon Sheep, NR = No Regeneration, P = Pigs, Pt = Potential, R = Rats, RF = Rock Fall, RV = Recreational Vehicles, S = Slugs, SD = Sedimentation, TF = Tree Fall, V = Volcanic Eruption, W = Wasps, X = Threat

C. CONSERVATION ASSESSMENT

1. Conservation Efforts

Numerous conservation efforts are occurring on the Hawai`i Island that may benefit the 15 listed species addressed herein. Large-scale efforts by watershed partnerships (see below) mainly focused on mitigating invasive plants or nonnative ungulates are critical, but may not address all the conservation needs of individual species. The efforts of the watershed partnerships as well as other voluntary conservation efforts certainly reduce the threats to the 15 recently listed species; however, the overwhelming number of threats as well as inadequate funding (see Leonard 2008) has made these efforts insufficient to date.

The three watershed partnerships on Hawai`i Island (Kohala Watershed Partnership, Mauna Kea Watershed Alliance, and Three Mountain Alliance) are voluntary alliances of public and private landowners “committed to the common value of protecting forested watersheds for water recharge, conservation, and other ecosystem services through collaborative management” (Hawai`i Association of Watershed Partnerships 2018). Most of the conservation management undertaken by the partnerships address threats to upland habitat from nonnative species (*e.g.*, feral ungulates, invasive plants) and may include fencing, ungulate removal, nonnative plant control, and outplanting of native species on partnership lands. These actions help protect rare species to preserve ecosystem function. Funding for the watershed partnerships is provided through a variety of State and Federal sources, public and private grants, and in-kind services provided by the partnership and/or volunteers.

The Plant Extinction Prevention Program (PEPP) focuses on those species with fewer than 50 individuals remaining in the wild. The goal of the program is to prevent extinction via guidelines set by the Hawai`i and Pacific Plants Recovery Coordinating Committee. These include having or establishing 3 to 6 populations of 25 to 75 (long-lived species), 50 to 150 (short-lived species), or 100 to 300 (annual species) mature, reproducing individuals (exact number dependent on biology of species); ensuring that all threats are managed; and having representatives of all individuals in genetic storage (HPPRCC 2011). The PEPP has monitored, accomplished threat management, and collected specimens or genetic material from *Bidens hillebrandiana* ssp. *hillebrandiana*, *Cyanea marksii*, *Cyanea tritomantha*, *Cyrtandra wagneri*, *Phyllostegia floribunda*, *Platydesma remyi*, *Schiedea diffusa* ssp. *macraei*, *Schiedea hawaiiensis*, and *Stenogyne cranwelliae* (Plant Extinction Prevention Program 2017). However, neither this program, nor any other, has been able to directly address landscape-scale threats to plants from invasive species.

Numerous landowners on Hawai`i Island are engaged in, or are initiating, conservation actions on their lands, including fencing to exclude ungulates, removing ungulates, controlling nonnative plants, and outplanting native and rare plants, all of which provide a conservation benefit and partially ameliorate threats to the 15 recently listed species. Many of these

landowners are partners in one of the watershed partnerships on Hawai`i Island, or cooperate or work collaboratively with watershed partnerships.

There are several plant propagation facilities in Hawai`i; those on Hawai`i Island include the U.S. Army Garrison – Pōhakuloa, Hawai`i Volcanoes National Park, and small plant nurseries run by the Hawai`i Island Seed Bank and Hawai`i's Division of Forestry and Wildlife. The Lyon Arboretum Micropropagation Laboratory and Seed Conservation Laboratory is located on O`ahu and provides services for all the Hawaiian Islands. The following species are currently in micropropagation, living material collections, or seed collections for genetic storage or reintroduction efforts: *Bidens micrantha* ssp. *ctenophylla*, *Cyanea marksii*, *Cyanea tritomantha*, *Cyrtandra nanawaleensis*, *Cyrtandra wagneri*, *Phyllostegia floribunda*, *Pittosporum hawaiiense*, *Platydesma remyi*, *Pritchardia lanigera*, *Schiedea diffusa* ssp. *macraei*, *Schiedea hawaiiensis*, and *Stenogyne cranwelliae* (Hawai`i Island Seed Bank 2018; Harold L. Lyon Arboretum Micropropagation Laboratory 2017; Harold L. Lyon Arboretum Seed Conservation Laboratory 2017; National Tropical Botanical Garden 2017; Hawai`i Volcanoes National Park 2016; U.S. Army Garrison – Pōhakuloa 2017; Volcano Rare Plant Facility 2016).

The Big Island Invasive Species Committee (BIISC) works to prevent the establishment of incipient pests on Hawai`i Island. Current priority species for control include these invasive nonnative plant species: *Pereskia aculeata* (Barbados gooseberry), *Cotoneaster pannosus* (silver leaf cotoneaster), *Ilex cassine* (Dahoon holly), *Photinia davidiana* (Chinese photinia), *Rubus sieboldii* (Molucca raspberry), *Cortaderia selloana* (Pampas grass), *Cryptostegia madagascariensis* (rubber vine), and *Buddleja madagascariensis* (smoke bush) (Big Island Invasive Species Committee 2018).

2. Summary Conservation Assessment

Overall, populations of the 15 listed species are declining and their ranges are restricted. However, the recovery prognosis for these species is thought to be positive because the populations are either of sufficient size to allow for successful management or can be reintroduced to increase numbers and distribution. Many of the threats to the species can be addressed by well-developed management actions such as fencing and controlling ungulates, invasive plants, and predators.

By mitigating the previously mentioned threats and initiating research to provide much needed life history information, population trends can be reversed and recovery can be achieved. Refining management protocols to minimize disturbance to sensitive areas, developing cost-effective conservation strategies, coordinating efforts among partners, and obtaining sufficient funding are critical to the recovery of these species.

II. Preliminary Recovery Strategy

A. RECOVERY PRIORITY NUMBERS

Recovery priority numbers are assigned to species or subspecies based on the degree of threat, the potential for recovery, and their taxonomic status (*i.e.*, full species vs. subspecies) and range from 1C (highest, “C” indicating the potential for conflict with human economic activities) to 18 (lowest) (USFWS 1983a, 1983b). All of the 15 species have a high degree of threat to their habitat and continued existence (Table 2). These threats are ongoing and include habitat loss and degradation by invasive nonnative plant species, feral ungulates, predation or herbivory by nonnative invertebrates and vertebrates, diseases, climate change, and the stochastic and demographic consequences associated with a low number of individuals and populations.

Pittosporum hawaiiense and *Pritchardia lanigera* are assigned a recovery priority number of 2 based on a high degree of threat, a high potential for recovery because their threats are well understood and can be alleviated, and because of their status as full species. *Bidens micrantha* ssp. *ctenophylla* is assigned a recovery priority number of 3, based on a high degree of threat, a high potential for recovery because its threats are understood and can be alleviated, and because of its status as a subspecies. *Cyanea marksii*, *Cyanea tritomantha*, *Cyrtandra nanawaleensis*, *Cyrtandra wagneri*, *Drosophila digressa*, *Phyllostegia floribunda*, *Platydesma remyi*, *Schiedea hawaiiensis*, *Stenogyne cranwelliae*, and *Vetericaris chaceorum* are assigned a recovery priority number of 5, based on a high degree of threat, a low potential for recovery due to a small number of individuals and some threats being well understood while others are difficult to mitigate, and because of their status as a species. *Bidens hillebrandiana* ssp. *hillebrandiana* and *Schiedea diffusa* ssp. *macraei* are assigned a recovery priority number of 6, based on a high degree of threat, a low potential for recovery due to a small number of individuals and some threats being well understood while others are difficult to mitigate, and because of their status as subspecies.

B. RECOVERY GOAL AND OBJECTIVES

The goal of the recovery plan is to establish a framework within which recovery actions are undertaken to ensure the long-term survival and recovery of the 15 listed species by controlling or reducing threats to these species to the extent that they no longer require the protections afforded by the ESA. Although subject to change, full recovery of the 15 species is currently envisioned as follows: viable populations that will persist on protected and managed habitat throughout the species' historical range; and threats to the species, primarily habitat loss and degradation and predation or herbivory by nonnative species, will be sufficiently abated to ensure the high probability of survival for at least 100 years. Fitting with the island-wide approach to recovery for these 15 species, the Service also will develop recovery objectives for individual management units.

C. INITIAL RECOVERY ACTION PLAN

The goal of the Hawai'i Island recovery plan will be to reverse population declines and increase the range of these 15 recently listed species. The objectives of the recovery plan will be to:

1. Protect ecosystems and control threats
 - 1.1. Identify and survey remaining extant populations for all species and the habitats in which they occur
 - 1.2. Develop fine-scale climate models to identify future suitable habitat based on existing and historical distributions and determine potential future climate conditions
 - 1.3. Identify areas within each habitat necessary for recovery and develop management units
 - 1.4. Ensure long-term protection of management units
 - 1.4.1. Identify threats specific to the management units
 - 1.4.2. Within management units, construct and maintain fencing, remove ungulates, and identify a funding stream to maintain fences and maintain their ungulate free status in perpetuity
 - 1.4.3. Eradicate habitat-modifying invasive plants from management units and maintain weed-free status.
 - 1.4.4. Develop and implement a rodent control program within management units
 - 1.4.5. Provide wildfire protection as necessary
 - 1.4.5.1. Develop management unit-specific fire management plans that incorporate management actions to reduce the likelihood of fire, especially for those management units in dry and mesic habitats
 - 1.4.5.2. Assess the need for additional fire management plans in all habitats
 - 1.4.6. Protect management units from human disturbance as necessary
 - 1.4.7. Control other threats as appropriate
2. Control species-specific threats
 - 2.1. Develop and implement control for slugs and update as new technology becomes available

- 2.2. Implement control for rodents and update as new technology becomes available
- 2.3. Develop and implement control for nonnative fish (for anchialine pool shrimp)
- 2.4. Develop and implement control for ants and wasps (for picture-wing fly)
- 2.5. Control other threats as appropriate
3. Expand the range of existing wild populations and establish new populations to increase resilience
 - 3.1. Develop habitat and climate models to identify areas within management units appropriate for establishing or augmenting populations
 - 3.2. Select populations for augmentation or sites for reintroduction
 - 3.3. Prepare reintroduction sites
 - 3.4. Propagate genetically appropriate individuals for genetic storage (for plants) and augmentation or reintroduction
 - 3.5. Release and translocate (for anchialine pool shrimp or picture-wing fly) or outplant (for plants) genetically appropriate individuals
4. Control new threats before they become widespread
 - 4.1. Facilitate surveys, focused on likely source areas (*e.g.*, airport), and control newly discovered pest or invasive species prior to their dispersal to management units
 - 4.2. Facilitate improved border security to prevent the influx of new pests and invasive species into the State and Hawai'i Island
5. Facilitate and conduct additional research essential to recovering species and restoring the habitats on which they depend
 - 5.1. Conduct studies on the range, demography, and dispersal of each species
 - 5.2. Conduct population viability analyses (PVA) for each species as appropriate
6. Develop and implement a detailed monitoring plan for each species and management unit
7. Develop objective and measureable downlisting and delisting criteria at the species and habitat levels as necessary to validate recovery objectives
8. Partner with key stakeholders to further develop and accomplish above objectives

9. For all recovery actions, evaluate management and research results and adapt management as necessary

D. RECOVERY ACTIONS

The recovery effort for the 15 recently listed species should build on ongoing conservation and monitoring efforts described above. Specific actions that should be undertaken or at least initiated early in the recovery planning process include the following:

- Continue to assess the distribution, current status, and potential future distribution of existing habitats and determine the most intact sites for management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority areas for targeting future surveys.
- Prioritize sites for recovery actions for each species.
- Initiate control of habitat-modifying threats, such as ungulates and invasive nonnative plants, as soon as possible, within the highest-priority management units.
- Protect all remaining extant populations by controlling species-specific threats (as indicated in section C, Initial Recovery Action Plan, #2).
- Conduct systematic surveys in areas of suitable habitat 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 for the species.
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Big Island Invasive Species Committee and promote secure funding for the program to improve border security.
- Prioritize and implement research that will provide information and tools to mitigate threats to the species and habitats, as well as techniques for captive propagation.
- Secure plant propagules or individuals (for picture-wing fly or anchialine pool shrimp) for captive propagation for genetic storage and reintroduction.
- Increase outreach efforts and coordination with State agencies, private landowners, and the military regarding habitat conservation. Promote opportunities to assist in the recovery of these species through habitat conservation plans, safe harbor agreements, integrated natural resources management plans, Federal action agency ESA section 7(a)(1) and 7(a)(2) consultation obligations, and through various conservation partnerships funded by State and Federal agencies and private organizations.

III. Preplanning Decisions

A. PLANNING APPROACH

A recovery plan for the 15 species listed in October 2013 will be prepared pursuant to section 4(f) of the ESA. Preparation of the recovery plan will be conducted by the Pacific Islands Fish and Wildlife Office.

B. INFORMATION MANAGEMENT

All information relevant to the recovery of the 15 species listed in October 2013 will be housed in the Pacific Islands Fish and Wildlife Office's administrative files. The Recovery Program will be responsible for maintaining a complete administrative record for the recovery planning and implementation process for these species. This recovery outline will be available on-line [here](#).

C. RECOVERY PLAN SCHEDULE

Public Review-Draft Recovery Plan	2021
Public Comment Period	60 days
Final Recovery Plan	2022

D. STAKEHOLDER INVOLVEMENT

Key stakeholders:

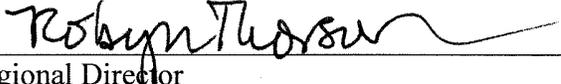
- Conservation organizations
- Local entities and County, State, and Federal agencies that own or manage lands occupied currently or historically by any of the 15 species or with habitat types suitable for establishing new populations
- Organizations representing native Hawaiians
- Outdoor sports and recreation organizations
- Private landowners who own property currently or historically occupied by any of the 15 recently listed species or with habitat types suitable for establishing new populations
- State of Hawai'i Department of Lands and Natural Resources, Division of Aquatic Resources
- State of Hawai'i Department of Lands and Natural Resources, Division of Forestry and Wildlife

- U.S. Geological Survey, Biological Resources Discipline, Pacific Island Ecosystems Research Center
- University of Hawai`i researchers

E. STAKEHOLDER INVOLVEMENT STRATEGY

Landowners and land managers that may be affected by the listing and recovery of the 15 recently listed species will be invited to participate in the recovery planning process. A mailing list will be maintained and the Pacific Islands Fish and Wildlife Office will foster open and ongoing communications with all interested parties. Service biologists working on the 15 species as well as other Hawai`i Island resource management issues will continue to develop strong working relationships with stakeholders. Early in the recovery planning process, a meeting with interested parties will be held to exchange status information, identify recovery issues, and identify additional cooperators. Information from this meeting will assist with recovery planning and help identify private landowners who could participate in recovery efforts. Interested stakeholders will be asked to participate, on an ongoing basis, in the recovery planning and implementation effort. As needed, additional meetings will be scheduled to discuss particular issues, and stakeholders will be invited to participate, as appropriate. Stakeholders may also be asked to contribute directly in developing recovery implementation strategies for planned actions. Stakeholders will be afforded an opportunity to review and comment on a draft of the recovery plan as per the ESA.

Approved:



Regional Director
U.S. Fish and Wildlife Service

Oct. 31, 2019
Date

Citation

U.S. Fish and Wildlife Service. 2019. Recovery Outline for Hawai`i Island. Portland, Oregon.
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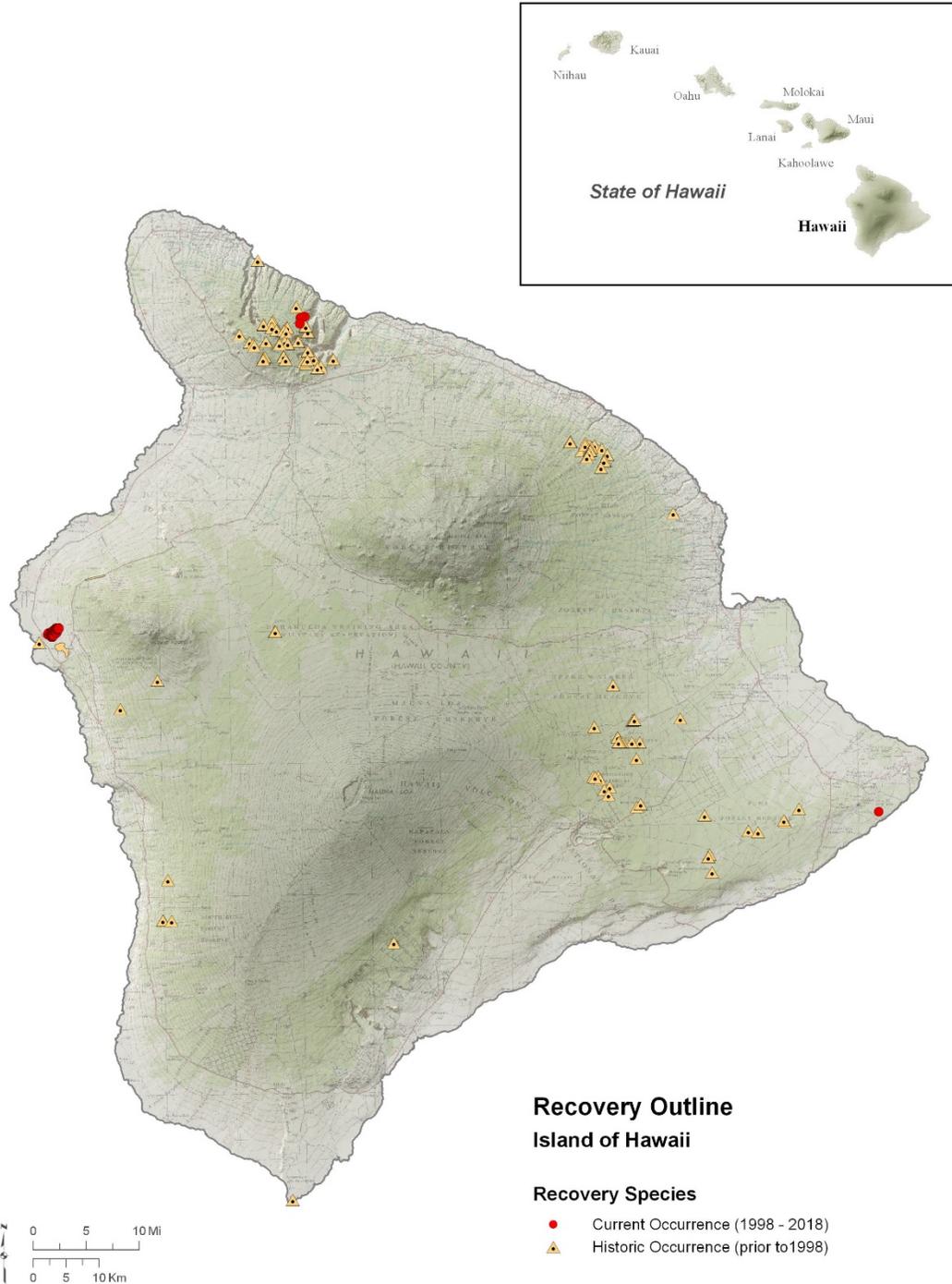
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Appendix: Maps.

Map 1: Current and Historic Distribution of Occurrences for the 15 Species across Hawai'i Island.



Map 2: Island of Hawai'i Species Habitat Types. Two habitats, coastal and anchialine pools, are identified as habitat types for *Bidens hillebrandiana* ssp. *hillebrandiana* and *Vetericaris chaceorum*, respectively, but not identified as habitat types for The Nature Conservancy's native ecosystems map.

**Recovery Outline
Island of Hawai'i**

Native Ecosystems

The Nature Conservancy of Hawaii

- Dry Cliff
- Lowland Dry Ecosystems
- Lowland Mesic Forest & Shrubland
- Lowland Wet Forest & Shrubland
- Montane Dry Forest & Shrubland
- Montane Mesic Forest & Shrubland
- Montane Wet Forest & Shrubland
- Wet Cliff

