U.S. Fish and Wildlife Service

Recovery Outline for Hawaiian Multi-Island Species

Scientific Name/ Common Name/ Hawaiian Name

PLANTS

Asplenium diellaciniatum/ no common name (NCN)
Calamagrostis expansa/ Maui reedgrass
Cyclosorus boydiae/ kupukupu makali‘i
Deparia kaalaana/ NCN
Dryopteris glabra var. *pusilla*/ hohiu
Exocarpos menziesii/ heau
Festuca hawaiiensis/ NCN
Gardenia remyi/ nānū
Haplostachys haplostachya/ honohono
Huperzia stemmermanniae/ NCN
Joinvillea ascendens subsp. *ascendens*/ ‘ohe
Kadua fluviatilis/ kamapua‘a
Kadua haupuensis/ NCN
Labordia lorenciana/ NCN
Lepidium orbiculare/ ‘ānaunau
Microlepia strigosa var. *mauiensis*/ palapalai
Myrsine fosbergii/ kōlea
Nothocestrum latifolium/ ‘aiea
Ochrosia haleakalae/ hōlei
Panicum faurei var. *carteri*/ Carter’s panicgrass
Phyllostegia brevidens/ NCN
Phyllostegia helleri/ NCN
Phyllostegia stachyoides/ NCN
Portulaca villosa/ ‘ihi
Pseudognaphalium sandwicensium var. *molokaiense*/ ‘ena‘ena
Ranunculus hawaiensis/ makou
Ranunculus mauiensis/ makou
Sanicula sandwicensis/ NCN
Santalum involutum/ ‘iliahi

Deparia kaalaana H. Oppenheimer

Oceanodroma castro A. Raine

Sicyos lanceoloideus/ ʻānunu
Sicyos macrophyllus/ ʻānunu
Solanum nelsonii/ pōpolo
Stenogyne angustifolia/ NCN
Wikstroemia skottsbergiana/ ʻākia

ANIMALS
Drepanis coccinea/ ʻiʻiwi
Drosophila differens/ Hawaiian picture-wing fly
Drosophila heteroneura/ Hawaiian picture-wing fly
Drosophila mulli/ Hawaiian picture-wing fly
Drosophila neoclavisetae/ Hawaiian picture-wing fly
Drosophila ochrobasis/ Hawaiian picture-wing fly
Hylaeus anthracinus/ Hawaiian yellow-faced bee
Hylaeus assimulans/ Hawaiian yellow-faced bee
Hylaeus facilis/ Hawaiian yellow-faced bee
Hylaeus longiceps/ Hawaiian yellow-faced bee
Megalagrion nesiotes/ flying earwig Hawaiian damselfly
Megalagrion pacificum/ Pacific Hawaiian damselfly
Megalagrion xanthomelas/ orangeblack Hawaiian damselfly
Oceanodroma castro/ band-rumped storm-petrel, Hawaiʻi DPS
Procaris hawaiana/ anchialine pool shrimp

Megalagrion xanthomelas D. Polhemus

Listing Status and Date: Endangered; November 29, 1979 (44 FR 62468), October 12, 1983 (48 FR 46328), May 9, 2006 (71 FR 26835), July 26, 2010 (75 FR 35990), September 30, 2016 (81 FR 67786); and Threatened; May 9, 2006 (71 FR 26835), September 20, 2017 (82 FR 43873).

Lead Agency/Region: U.S. Fish and Wildlife Service, Interior Region 12

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Purpose of the Recovery Outline: This document lays out a preliminary course of action for the survival and recovery of 49 listed species from multiple islands; 38 of the species occur on multiple islands, and the remaining are endemic to a single island (USFWS 1979, USFWS 1983, USFWS 2006, USFWS 2010, USFWS 2016a,b; USFWS 2017). 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 these listed species. To achieve recovery of these species, a recovery plan will delineate 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 since funding is not available to manage all units or threats simultaneously.

This outline is meant to serve as interim guidance directing recovery efforts and informing consultation and permitting activities until a comprehensive recovery plan has been completed. The eight plants endemic to Kaua‘i included in this recovery outline will be included in a future Addendum to the Kaua‘i Islandwide Recovery Plan. 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 during the recovery planning process. For more information on Federal recovery efforts for these 49 listed species, or to provide comments, interested parties may contact the lead field office for these species at the above address and phone number.

Scope of Recovery and Available Information: The scope of this effort is at the island level. This recovery outline is based on the best available scientific data contained in the listing decisions (44 FR 62468, November 29, 1979; 48 FR 46328, October 12, 1983; 71 FR 26835, May 9, 2006; 75 FR 35990, July 26, 2010; 81 FR 67786, September 30, 2016; 82 FR 43873, September 20, 2017), the Species Status Assessment Report for

the ‘i‘iwi (*Drepanis coccinea*; USFWS 2016b, 121 pp.), the draft recovery plans (USFWS 1993, 1994) and 5-year status reviews for *Haplostachys haplostachya*, *Panicum faurei* var. *carteri*, and *Stenogyne angustifolia* (2011b, 2012a,b; 2018a), and information in our files. Many of the threats to these species and their habitats are well understood and include introduced species such as feral ungulates and invasive plants. Little information beyond current status and existing threats is available for most of these species. Additional research is needed to fully understand what is required for the recovery of these species, especially with regard to plant pollinators and loss of reproductive vigor as well as the effects of climate change on their distribution and the habitats on which they depend. Uncertainties associated with specific habitat needs and biology of these species will be resolved to the extent possible through the recovery 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, life history information, and historical and current population status accounts for the 49 species are contained in the final listing decisions (USFWS 2006, USFWS 2010, USFWS 2016a, USFWS 2017), and in the species status report for the ‘i‘iwi (USFWS 2016b, 121 pp.).

2. Historical and Current Population Status

The historical and current population status of these species also are contained in the 5-year status reviews (USFWS 2012a,b; USFWS 2018a), final listing decisions (USFWS 1979, USFWS 1983, USFWS 2006, USFWS 2010, USFWS 2016a, USFWS 2017), the proposed listing rules (USFWS 2005, USFWS 2009, USFWS 2015) for these listed species, and partner reports (for *Stenogyne angustifolia;* Pōhakuloa Training Area 2017, 2018) (Table 1).

Table 1. Species name, Federal listing status, numbers of populations and individuals, and their current and historical distribution across the Hawaiian Islands.

PLANTS				
Scientific name	Listing Status	Populations	Individuals	Distribution (Current and **Historical**)
Asplenium diellaciniatum	E	3	100	KA
Calamagrostis expansa	E	13-33	750	HA, MA
Cyclosorus boydiae	E	13	~ 400	**HA**, MA, OA
Deparia kaalaana	E	1	0[1]	**HA**, MA, **KA**
Dryopteris glabra pusilla	E	1	<250	KA
Exocarpos menziesii	E	7	1,800	HA, **LA**
Festuca hawaiiensis	E	4	1,500	HA, **MA**
Gardenia remyi	E	16	~ 90	HA, MA, MO, KA
Haplostachys haplostachya	E	2	>10,000	HA, **MA, KA**
Huperzia stemmermanniae	E	1	<20	HA, **MA**
Joinvillea ascendens subsp. *ascendens*	E	56	~200	HA, MA, MO, OA, KA
Kadua fluviatilis	E	1	20–25	OA, KA
Kadua haupuensis	E	0	0[1]	**KA**
Labordia lorenciana	E	1	4	KA
Lepidium orbiculare	E	1	<50	KA
Microlepia strigosa mauiensis	E	9	<100	HA, MA, OA
Myrsine fosbergii	E	2	<85	OA, KA
Nothocestrum latifolium	E	21	1,600	MA, **LA**, MO, OA, **KA**
Ochrosia haleakalae	E	7	165	HA, MA
Panicum faurei var. *carteri*	E	1	<100	**MA,** MO, **OA**
Phyllostegia brevidens	E	2	3	HA, MA
Phyllostegia helleri	E	1	4	KA
Phyllostegia stachyoides	E	6	<45	**HA**, MA, MO
Portulaca villosa	E	9	55	HA, MA, KH, **LA**, MO, **OA**, **KU, LE**, **NH**
Pseudognaphalium sandwicensium molokaiense	E	3	~20,000	MA, **LA**, MO, **OA**
Ranunculus hawaiensis	E	6	14	HA, **MA**
Ranunculus mauiensis	E	2	165	**HA**, MA, **MO**, **OA**, KA
Sanicula sandwicensis	E	4	<100	HA, MA
Santalum involutum	E	<10	50–100	KA

Table 1 cont.

PLANTS				
Scientific name	Listing Status	Populations	Individuals	Distribution (Current and **Historical**)
Sicyos lanceoloideus	E	8	<39	OA, KA
Sicyos macrophyllus	E	10	24–26	HA, **MA**
Solanum nelsonii	E	9	8,000–15,000	HA, **MA**, MO, **NI**, **NH**, **PH**, **LY, MI**, **KR**
Stenogyne angustifolia	E	1	~1,200-3,200	HA, **MA, MO**
Wikstroemia skottsbergiana	E	1	30	KA
ANIMALS				
Drepanis coccinea	T	9	>600,000	HA, MA, **LA**[2], MO[2], OA[2], KA
Drosophila differens	E	1	?	MO
Drosophila heteroneura	E	1	?	HA
Drosophila mulli	T	2	<10	HA
Drosophila neoclavisetae	E	?	?	**MA**
Drosophila ochrobasis	E	1	?	HA
Hylaeus anthracinus	E	15	?	HA, MA, KH, **LA**, MO, OA
Hylaeus assimulans	E	5	?	MA, KH, LA, **OA**
Hylaeus facilis	E	2	?	**LA**, MO, OA
Hylaeus longiceps	E	6	?	MA, LA, MO, OA
Megalagrion pacificum	E	1	?	HA, MA, **KA, LA, MA**, MO, **OA**
Megalagrion nesiotes	E	1	?	**HA**, MA
Megalagrion xanthomelas	E	16	?	HA, MA, LA[2], MO, OA, **KA**
Oceanodroma castro	E	?	Hawai‘i DPS/greatly reduced	HA, MA[2], KH[2], LA[2], MO[2], OA[2], KA, LE, NH[2], KU[2]
Procaris hawaiana	E	27	?	HA, MA

E = endangered; T = threatened
HA = Hawai‘i, KA = Kaua‘i, KH = Kaho‘olawe, KU = Ka‘ula, KR = Kure, LA = Lāna‘i, LE = Lehua, LY = Laysan, MA = Maui, MI = Midway, MO = Moloka‘i, NH = Nihoa, NI = Ni‘ihau, OA = O‘ahu, PH = Pearl and Hermes
1 = birds not known to be nesting on these islands
2 = in propagation only
BOLD type = historical, last observed > 20 years ago

3. Habitat Description and Landownership

These listed species are known from 13 habitat types: anchialine pools, lentic systems, streams, coastal, lowland dry, lowland mesic, lowland wet, montane dry, montane mesic, montane wet, subalpine, dry cliff, and wet cliff. Two of the three previously listed plants are known from montane dry habitats (*Haplostachys haplostachya, Stenogyne angustifolia*; USFWS 1993), and the third is known from basalt substrates of windward coastal cliffs well within the salt spray zone (*Panicum faurei* var. *carteri*; USFWS 1994), the latter in which critical habitat has been designated on Mokoliʻi islet off of Oʻahu (USFWS 1983). The damselfly species occur in lentic systems and streams. The *Drosophila* species are known from wet forest, mesic to wet forest, mesic forest, and dry to mesic forest. These species and their habitats occur on Federal, State, County, and private lands. Delineation of critical habitat was not determinable for these species (with the exception of *P. faurei* var. *carteri*) at the time of the listing decisions (USFWS 2016 and USFWS 2017). Critical habitat was designated for the *Drosophila* species after listing (USFWS 2008).

4. Summary Biological Assessment

The species addressed in this recovery outline face threats throughout their entire range. With effective management, the species with moderate to high recovery potential are anticipated to respond. Habitat management in Hawaiʻi has shown that the potential for recovery is high if major threats are controlled. The greatest threats to listed plant species are invasive species, including habitat modification and destruction by introduced ungulates (*i.e.*, pigs, goats, axis deer [*Axis axis*], black-tailed deer [*Odocoileus hemionus*], mouflon [*Ovis orientalis*], and cattle) and invasive plants, herbivory by introduced ungulates, rodents, and slugs, and competition with nonnative invasive plants. Other threats include fire, the effects of climate change including increased temperatures and drought, the effects of stochastic events such as landslides, flooding, drought, and hurricanes, human disturbance, and vulnerability to extinction due to demographic and genetic consequences of small populations. The greatest threats to listed animal species are habitat loss and degradation due to urbanization, introduced ungulates, nonnative invasive plants, fire, and water extraction; predation by nonnative feral ungulates, cats (*Felis catus*), barn owls (*Tyto alba*), rats (*Rattus* spp.), fish, bullfrogs (*Lithobates catesbeianus*), Jackson's chameleons (*Chamaeleo jacksonii*), ants, and wasps; disease (avian malaria and avian pox), stochastic events such as flooding, drought, tsunami, and hurricanes; human activities such as recreational use of anchialine pools, dumping of nonnative fish and trash into anchialine pools, artificial night lighting, and manmade structures; and the genetic consequences of small populations.

In Hawaiʻi, landscape-level management of threats such as those caused by ungulates and nonnative invasive plants has been shown to be successful in many cases. As an example of landscape-level management, an ungulate exclosure on the island of Hawaiʻi demonstrated rapid recovery in height, growth, and numbers of vegetative resprouts of *Acacia koa* (koa) (Spatz and

Mueller-Dombois 1973) in fenced areas protected from goats. After removal of grazing animals at Puʻu Waʻawaʻa Forest Reserve in 1985, *A. koa* and *Metrosideros polymorpha* (ʻōhiʻa) seedlings germinated by the thousands (Hawaiʻi Department of Land and Natural Resources 2002). Loope *et al.* (1991) found that native plant cover increased from 6 to 95 percent 6 years after pigs were excluded from a montane bog on Maui. In Hawaiʻi Volcanoes National Park, herbicide control of the invasive grass *Pennisetum clandestinum* (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 the removal of *Pennisetum setaceum* or *Cenchrus setaceus* (fountain grass). Adaptive management methods, such as slow removal of *Morella faya* (faya tree) by girdling resulted in better recovery of native plant species, as measured by recovery of a more diverse suite of species and a decrease of introduced plant species compared to clear cut areas after 3 years (Loh and Daehler 2007, 2008).

The management of additional threats, such as predation of seabirds and forest birds by cats, barn owls, and rats; and herbivory of plants by rats and slugs, is possible, and research continues on the most efficient and effective control methods (Mosher *et al.* 2010; Raine *et al.* 2019). Research is also underway to determine the best cross-pollination, storage, propagation, and reintroduction methods to increase the success of reestablishing individuals and populations of plant species (Perlman 2008). Translocation of damselflies to establish new populations is ongoing (Preston *et al.* 2007). Artificial nesting substrates for Hawaiian yellow-faced bees are being field tested to establish additional populations (Graham *in* Meek 2017). The importance of protection of groundwater resources for anchialine pools is demonstrated by National Park outreach efforts (NPS 2016).

While the best available scientific information indicates that the current and known historical distribution of many of these species is limited, it is very likely that many were much wider ranging prior to human colonization of the Hawaiian Islands (Burney *et al.* 2001). Further systematic surveys are needed to assess the current distribution of these species and their habitat requirements so that recovery areas can be expanded. Habitat modeling will assist in selecting additional areas needed for recovery. Models incorporating climate change projections have been developed that delineate potential future distributions for most Hawaiian plant species and are currently being further refined (Fortini *et al.* 2013).

The Pacific Islands Fish and Wildlife Office's Strategic Plan (USFWS 2011a) identifies priority ecosystem conservation areas (or priority landscapes) across the main Hawaiian Islands. Priority landscapes encompass key native ecosystems that, when appropriately managed, may provide for the long-term viability of entire native 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 2011a), and other surveys and conservation planning documents. The

priority landscape maps will be used to help develop Hawai‘i recovery plans and conservation strategies for these species.

Resiliency, Redundancy, and Representation:

Resiliency, Redundancy, and Representation (the “3Rs”) describe key characteristics that collectively contribute to a species’ ability to sustain secure populations over the long term (Smith *et al*. 2018). 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. Resiliency describes an individual population’s ability to tolerate environmental and demographic stochasticity, such as fluctuations in temperature or genetic drift. Redundancy is the ability of populations to withstand catastrophic events (hurricanes, wildfires, etc.). Representation is the adaptability and evolutionary capacity of a species over time, to accommodate long-term issues like climate change. The 3Rs are interconnected and overlapping. For example, populations must be resilient 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. 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. Almost all of the 49 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 49 species because of their endemism, small number of populations, low to moderate resiliency of populations, and restricted habitats.

Species occupying 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 a widely-distributed species. For example, the local reduction of host tree availability or a local increase in predation of picture-wing fly adults would likely have little

demographic consequences if the species was widely-distributed; but could result in a significant decrease in survivorship or reproduction given the limited distribution of this species. Thus, 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 with populations having low genetic variability or those that occupy habitats with limited diversity are at a higher risk of extinction than those with greater genetic diversity or which occupy diverse habitats. The former populations have lower representation when compared to the latter populations. Many of the 49 species have low representation, with 14 plants and eight animals restricted to either one or two populations. Deforestation, invasive species, and effects of climate change have contributed to habitat loss and fragmentation and resulted in limited variation in habitats for the 49 species. Overall, representation is low to moderate 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 projected environmental impacts that may result from changes in climate and subsequent impacts to their habitats.

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

B. THREATS ASSESSMENT

1. Listing Factors/Primary Threats to the Species

Threats to these listed species (Table 2) are identified and described in the final listing rules (USFWS 1979, USFWS 1983, USFWS 2006, USFWS 2010, USFWS 2016a, and USFWS 2017), and each is classified according to the five factors as identified in section 4 of the Endangered Species Act (16 USC 1531 *et seq*.; [Act]). Additional threat information for three plant species (*i.e.*, *Haplostachys haplostachya, Panicum faurei* var. *carteri*, and *Stenogyne aungustifolia*) can be found in draft recovery plans (USFWS 1993, 1994) and 5-year status reviews (USFWS 2011a, 2012a, 2012b, 2018a).

Table 2. Recovery priority numbers, habitat, and threat summary for the 49 listed species. 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	Recovery Priority Number		Factor A						Factor B	Factor C				Factor D	Factor E
		Habitats	Agriculture and urban development and military use	Ungulates	Invasive plants	Fire	Stochastic events	Climate change	Over-utilization	Disease	Predation / herbivory by ungulates	Predation / herbivory by other nonnative vertebrates	Predation / herbivory by nonnative invertebrates	Inadequacy of regulatory mechanisms	Other species-specific threats
PLANTS															
Asplenium diellaciniatum	5	MM		P, G, BTD	✓			✓			✓			✓	LN
Calamagrostis expansa	5	MW		P	✓			✓, Ft			✓	R		✓	LN
Cyclosorus boydiae	5	LW, MW	WE	P	✓		DR, F, L	✓, Ft			✓			✓	LN
Deparia kaalaana	5	LM, LW		P	✓		DR, F	✓			✓		S	✓	LN
Dryopteris glabra pusilla	6	MW		P, BTD	✓		L	✓, Ft				R	S	✓	LN
Exocarpos menziesii	5	LM, MM, MD		G, M, SH	✓	✓		✓, Ft			✓			✓	LN
Festuca hawaiiensis	5	MD		G, SH	✓	✓		✓, Ft			✓			✓	LN
Gardenia remyi	5	LM, LW		P, G, D	✓		L	✓, Ft			✓	R		✓	LN, NR
Haplostacys haplostachya	1	MD	✓	P, G, SH	✓	✓	DR	✓, Ft		F	✓		APH	✓	
Huperzia stemmermanniae	5	MW		P, G, D, C	✓		DR	✓, Ft			✓			✓	LN
Joinvillea a. ascendens	6	LM, LW, MW, MM		P, G, D, BTD	✓	✓	L	✓, Ft			✓	R		✓	LN, NR
Kadua fluviatilis	5	LM, LW		P, G	✓		L	✓, Ft			✓			✓	LN
Kadua haupuensis	5	LM		P	✓		L	✓				R		✓	LN
Labordia lorenciana	5	MM		P, G, BTD	✓	✓	F, L, TF	✓			✓	R	BTB	✓	LN, NR
Lepidium orbiculare	5	LM		P, G	✓		L	✓						✓	LN
Microlepia strigosa mauiensis	6	LM, MW, MM		P, G	✓			✓						✓	HY, LN

Table 2 cont.

Species	Recovery Priority Number	Habitats	Factor A						Factor B	Factor C				Factor D	Factor E
			Agriculture and urban development and military use	Ungulates	Invasive plants	Fire	Stochastic events	Climate change	Over-utilization	Disease	Predation / herbivory by ungulates	Predation / herbivory by other nonnative vertebrates	Predation / herbivory by nonnative invertebrates	Inadequacy of regulatory mechanisms	Other species-specific threats
PLANTS cont.															
Myrsine fosbergii	5	LM, LW, MW		P, G	✓			✓, Ft			✓			✓	HY, LN
Nothocestrum latifolium	5	LD, LM, DC		P, G, D, BTD, M, C	✓	✓		✓, Ft			✓		BTB	✓	LN, NR
Ochrosia haleakalae	5	LM, MM, DC		P, G, C	✓	✓		✓, Ft			✓	R	S	✓	LN, NR
Panicum faurei var. *carteri*	9	CO	✓	G	✓			✓, Ft				R	A	✓	LN
Phyllostegia brevidens	5	LW, MW, WC		P	✓		E, L	✓, Ft			✓		S	✓	LN
Phyllostegia helleri	5	LW, MW, WC		P, G	✓		L	✓, Ft				R		✓	LN
Phyllostegia stachyoides	5	MW, MM		P, G, D	✓		DR, E, F, L, RF	✓, Ft			✓	R	S	✓	LN
Portulaca villosa	5	CO, LD, MD		G, D, M, C	✓	✓	L, RF	✓, Ft			✓			✓	LN
Pseudognaphalium sandwicensium molokaiense	3	CO		G, D	✓		L, RF	✓, Ft			✓			✓	LN
Ranunculus hawaiensis	5	MM, MD, SA		P, M, C	✓		DR, E	✓, Ft			✓			✓	LN
Ranunculus mauiensis	5	MW, MM, WC		P, G, D, BTD, C	✓	✓	DR, E, L	✓, Ft			✓	R	S	✓	LN
Sanicula sandwicensis	5	MM, MD, SA		P, G	✓	✓	DR, E, F	✓, Ft			✓	R		✓	LN
Santalum involutum	5	LM, LW		P, G	✓	✓		✓			✓	R		✓	LN
Sicyos lanceoloideus	5	LM, MM, DC		P, G, BTD	✓	✓	DR	✓, Ft			✓			✓	LN
Sicyos macrophyllus	5	MW, MM, MD		P, M, C	✓	✓		✓, Ft			✓	R		✓	LN
Solanum nelsonii	5	CO		D, C	✓	✓	DR, E, F, TS	✓, Ft			✓	R		✓	LN, SL

Table 2 cont.

Species	Recovery Priority Number		Factor A						Factor B	Factor C				Factor D	Factor E
		Habitats	Agriculture and urban development and military use	Ungulates	Invasive plants	Fire	Stochastic events	Climate change	Over-utilization	Disease	Predation / herbivory by ungulates	Predation / herbivory by other nonnative vertebrates	Predation / herbivory by nonnative invertebrates	Inadequacy of regulatory mechanisms	Other species-specific threats
PLANTS cont.															
Stenogyne angustifolia	2	MD	✓	P, G, SH	✓	✓	DR	✓, Ft			✓			✓	HY
Wikstroemia skottsbergiana	5	LW		P, G	✓		L	✓				R		✓	LN
ANIMALS															
Drepanis coccinea	11			P, G, D	✓			✓		AM, AP		R			ROD
Drosophila differens	5	MW		G, P, D	✓	✓	DR, UR, LHP, LN	✓					A, W	✓	LN, W, B, LHP
Drosophila heteroneura	5	MW		G, P, D	✓	✓	DR, UR, LHP, LN	✓					A, W	✓	LN, W, B, LHP
Drosophila mulli	5	MW		G, P, D	✓	✓	DR, UR, LHP, LN	✓					A, W	✓	LN, W, B, LHP
Drosophila neocavisetae	5	MW		G, P, D	✓	✓	DR, UR, LHP, LN	✓					A, W	✓	LN, W, B, LHP
Drosophila ochrobasis	5	MW		G, P, D	✓	✓	DR, UR, LHP, LN	✓					A, W	✓	LN, W, B, LHP
Hylaeus anthracinus	5	CO, LD	✓	P, G, D, SH, C	✓	✓	DR, HUR, TS	✓					A, W	✓	LN, W, B, LHP
Hylaeus assimulans	5	CO, LD	✓	P, G, D, M, C	✓	✓	DR, HUR, TS	✓					A, W	✓	LN, W, B, LHP
Hylaeus facilis	5	CO, LD, LM	✓	P, G, D, C	✓	✓	DR, HUR, TS	✓					A, W	✓	LN, W, B, LHP

Table 2 cont.

Species	Recovery Priority Number	Habitats	Factor A						Factor B	Factor C				Factor D	Factor E
			Agriculture and urban development and military use	Ungulates	Invasive plants	Fire	Stochastic events	Climate change	Over-utilization	Disease	Predation / herbivory by ungulates	Predation / herbivory by other nonnative vertebrates	Predation / herbivory by nonnative invertebrates	Inadequacy of regulatory mechanisms	Other species-specific threats
ANIMALS cont.															
Hylaeus longiceps	5	CO, LD	✓	D	✓	✓	DR, HUR, TS	✓					A, W	✓	LN, W, B, LHP
Megalagrion nesiotes	5	AP, CO, LD, LM	WE	P, G, D	✓		DR, F, HUR	✓				FS, BF, JC	BS	✓	LN, CD
Megalagrion pacificum	5	AP, CO, LD, LM	WE	P, G, D	✓		DR, F, HUR	✓				FS, BF, JC	BS	✓	LN, CD
Megalagrion xanthomelas	5	AP, CO, LD, LM	WE	P, G, D	✓		DR, F, HUR	✓				FS, BF, JC	BS	✓	LN, CD
Oceanodroma castro	6	CO, SA, DC, WC		G	✓		E, L, HUR	✓				R, O, CA, MO		✓	LI, ST, H, LN
Procaris hawaiana	5	AP	WE				TS	✓	✓			FS		✓	FS, H, LN, RU, SD, SL

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

Factor D = Inadequacy of regulatory mechanisms: the ✓ in this column indicate that existing regulatory mechanisms do not ameliorate the threats to the species such that listing is not warranted (we do not identify Factor D, in and of itself, as a threat to the species).

A = Ants; AM = Avian Malaria; AP = Avian Pox; APH = Aphids; B = Bees (*competition*); BF = Bullfrog; BS = Backswimmer; BTB = Black Twig Borer; BTD = Black-tailed Deer; C = Cattle; CA = Cat; CD = Caddisfly; D = Axis Deer; F = fungus (powdery mildew); FS = Fish; G = Goat; JC = Jackson's Chameleon; M = Mouflon; MO = Mongoose; O = Barn Owl; P = Pig; R = Rat; S = Slug; SH = Sheep; W = Wasp (*competition*, *predation*).

DR = Drought; E = Erosion; F = Flooding; Ft = assessed in Fortini *et al.* (2013) climate change vulnerability analysis; H = Human (*fisheries*, *marine debris*, *dumping trash, contamination*); HUR = Hurricane; HY = Hybridization; L = Landslide; LHP = Loss of Host Plant; LI = Lights; LN = Low Numbers; NR = No Regeneration; RF = Rock Fall; ROD = Rapid ʻŌhiʻa Death; RU = Recreational Use (*swimming*, *bathing*); SD = Sedimentation; SL = Sea Level Rise; ST = Structures; TF = Tree Fall; TS = Tsunami; WE = Water Extraction

2. Summary Threats Assessment

With the exception of drought, climate change, invertebrate predation, and powdery mildew recently identified as threats to *Haplostachys haplostachya* and *Stenogyne angustifolia*, and goats, invasive plants, climate change, and rodent and ant herbivory and seed predation for *Panicum faurei* var. *carteri* during the 5-year status review process (USFWS 2011b, 2012a,b; 2018), no new threats have been identified since the listing rules were published (see Table 2). All threats will be addressed in the recovery plan.

Our analyses include 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, p. 78). 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, p. 78). 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 use expert judgment to weigh relevant information, including uncertainty, in considering how various aspects of climate change threaten the recovery of the species herein.

Most of the species addressed herein 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. 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 changing climate.

C. CONSERVATION ASSESSMENT

1. Conservation Efforts

Ongoing conservation actions for these species are summarized in the final listing decisions (USFWS 2006, USFWS 2010, USFWS 2016a, USFWS 2017), and the species status report for the ʻiʻiwi (USFWS 2016b, 121 pp.). Additional information on these conservation actions for three of the plant species (*Haplostachys haplostachya, Panicum faurei* var. *carteri*, and *Stenogyne aungustifolia*) can be found in draft recovery plans (USFWS 1993, 1994) and 5-

year status reviews (USFWS 2011b, 2012a, 2012b, 2018a). Numerous conservation efforts conducted by landowners and land managers that may benefit these listed species are described below. Large-scale efforts by watershed partnerships (see below), mainly focus 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 combined with other voluntary conservation efforts certainly reduce the threats to the listed species, however the overwhelming number of threats as well as inadequate funding (see Leonard 2008) makes these efforts insufficient.

The Hawai‘i Association of Watershed Partnerships (HAWP) consists of 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" (HAWP 2019). Most of the ongoing management undertaken by the partnerships addresses threats to upland habitat from nonnative species (*e.g.*, feral ungulates, nonnative plants) and may include fencing, ungulate removal, nonnative plant control, and planting of native species on lands within the partnership. These actions can contribute to the protection of rare species within the partnership area so that ecosystem functions are preserved (HAWP 2019). 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 partners or volunteers.

A safe harbor agreement between Kamehameha Schools, the State Department of Land and Natural Resources, and the Service was signed in June 2018 (USFWS 2018b). The area covered by the agreement is 32,207 acres (ac) (13,034 hectares (ha)) owned by Kamehameha Schools on Hawai‘i Island. The 50-year agreement will contribute to the recovery of five species included in this outline: *Joinvillea ascendens* subsp. *ascendens*, *Ranunculus hawaiensis*, *Sicyos macrophyllu*s, *Stenogyne angustifolia,* and the ‘i‘iwi. The agreement is part of an ongoing watershed partnership effort managed by the Three Mountain Alliance Watershed Partnership. Habitat management activities covered by this agreement include planting of native plants, control of invasive plants, koa silviculture, predator control, fencing and ungulate removal, fire threat management, response efforts to rapid ‘ōhi‘a death, and other land management activities that assist in the maintenance and enhancement of native forest and the species they support.

National Parks (NPs), National Wildlife Refuges (NWRs), State Natural Area Reserves (NARs), and State Wilderness Preserves play an important role in the protection and conservation of native habitat that support the 49 recently listed species.

The National Park Service has active conservation programs within its parks in the Hawaiian Islands to eliminate invasive plants and ungulates as well as other threats to native plants and animals such as non-native predators (*e.g.*, cats, rodents). Both Hawai‘i Volcanoes and Haleakalā National Parks have significant natural areas protected within their fenced boundaries, and both manage their natural areas for native species and their habitats, and conduct recovery actions (*e.g.*, monitoring, collection of propagules, propagation, and reintroduction) for

19 of these 49 listed species. Kaloko-Honokōhau National Historical Park manages anchialine pools and other groundwater and nearshore systems. The National Wildlife Refuge system is devoted to the protection of pelagic avifauna, rare waterbirds, and endangered passerines in the Northwestern Hawaiian Islands and in the main Hawaiian Islands (USFWS 2011a). In Hawai‘i, conservation efforts by NWRs are focused on the protection and conservation of endangered forest birds (see below) and plant populations in upland montane forests as well as on the protection of endangered waterbirds. Five of these 49 listed species occur within the NWR system.

The DLNR’s Division of Forestry and Wildlife, Native Ecosystems Protection and Management Program’s (NEPM) mission is to manage and protect watersheds, native ecosystems, and cultural resources, and to provide outdoor recreation and sustainable forest products opportunities while facilitating partnerships, community involvement, and education (State of Hawai‘i, NEPM 2019). The NARs System was established to preserve specific land and water areas that support communities of the natural flora and fauna, as well as geological sites, of Hawai‘i (State of Hawai‘i, DOFAW 2019). Currently, there are 21 NARs on 5 islands.

Forest protection, conservation, and restoration can benefit the ‘i‘iwi by maintaining and enhancing breeding and foraging habitat for the species, and by reducing mosquito breeding sites. Efforts to restore continuous tracts of native forests have met with some success in this regard, especially when combined with fencing and ungulate removal. For example, Hakalau Forest National Wildlife Refuge (almost 33,000 ac [13,355 ha]), as part of its comprehensive conservation plan, implements propagation and outplanting of common and rare native plants for restoration of forest bird habitat, combined with fencing and removal of ungulates (USFWS 2010). Since 1989, almost 400,000 trees and understory species have been planted (USFWS 2019). Studies have shown that these restored forests have been rapidly colonized by native forest birds, including ‘i‘iwi (Paxton *et al*. 2018). A new approach to mosquito control, introducing sterile male mosquitoes to reduce population viability, has the potential to achieve landscape-scale control of mosquitoes that carry avian malaria (International Union for the Conservation of Nature 2016, *in litt*.).

Private landowners of Lāna‘i began development of an island-wide conservation plan (prepared by Pūlama Lāna‘i) under a 2015 Memorandum of Understanding with the Service. The plan will provide landscape-scale management to benefit habitat for reintroduction of *Exocarpos menziesii* (heau), *Nothocestrum latifolium* (‘aiea), *Portulaca villosa* (‘ihi), and *Pseudognaphalium sandwicensium* var. *molokaiense* (‘ena‘ena); lowland dry and mesic habitat that supports the Hawaiian yellow-faced bees *Hylaeus longiceps* and *H. assimulans*, and anchialine pools and ephemeral ponds for the orangeblack Hawaiian damselfly *Megalagrion xanthomelas*. The management actions outlined in the plan should help ameliorate the primary threats to, and provide needed recovery actions for, habitats that support these species.

Other recovery actions for two yellow-faced bee species (*Hylaeus anthracinus* and *H. longiceps*) include controlling invasive ants, restoring native habitat, and protecting coastal habitat on Oʻahu. On Maui, the Hawaiian Islands Land Trust protects approximately 24 ac (10 ha) of coastal wetlands, 103 ac (42 ha) of dunes, and 8 ac (3 ha) of riparian habitats for native habitat restoration efforts at their Waiheʻe Coastal Dunes and Wetland Refuge (Land Trust Alliance 2018). This area is currently occupied by *H. longiceps*, and was historically occupied by *H. anthracinus* and *H. assimulans*. Key partners for the funding and management of this area are the County of Maui, the Service, the National Oceanic and Atmospheric Administration, and USDA-Natural Resources Conservation Service. Research on habitat requirements and limiting factors (*e.g.*, suitable nest sites, floral resources) are currently underway and will inform future recovery actions for the four yellow-faced bee species on Hawaiʻi Island, Maui, Kahoʻolawe, Lānaʻi, Molokaʻi and Oʻahu (DLNR 2018).

The Plant Extinction Prevention Program (PEPP) focuses on plant species with fewer than 50 individuals remaining in the wild (PEPP 2018). The goal of the program is to prevent extinction via guidelines set by the Hawaiʻi and Pacific Plants Recovery Coordinating Committee. These include having or establishing 3 to 6 populations of 25 to 75 (for long-lived species), 50 to 150 (for short-lived species), or 100 to 300 (for annual species) mature, reproducing individuals; ensuring that all threats are managed, documenting natural reproduction at each population, and having all individuals represented in genetic storage (HPPRCC 1998, 2011; PEPP 2017, pp. 2–19). The PEPP collects, propagates, or outplants 13 of the plant species covered in this outline: *Asplenium diellaciniatum*, *Deparia kaalaana, Huperzia stemmermanniae*, *Kadua haupuensis, Labordia lorenciana*, *Lepidium orbiculare*, *Phyllostegia brevidens*, *P. helleri*, *P. stachyoides*, *Ranunculus hawaiensis*, *Sicyos lanceoloideus*, *Sicyos macrophyllus,* and *Wikstroemia skottsbergiana* (PEPP 2017, pp. 56, 58–60, 147, 150, 169, 175–177, 213). The program also conducts surveys, fences important habitat, and controls invasive plants, rodents, and slugs in areas where populations of PEPP species occur. However, the program has not yet been able to directly address landscape-scale habitat threats to plants from invasive species.

All the plant species covered in this outline are represented to some extent, in living material collections or seed collections for genetic storage or reintroduction efforts with the exception of the following species: *Asplenium diellaciniatum, Festuca hawaiiensis,* and *Wikstroemia skottsbergiana* (PEPP 2017, Haleakalā National Park 2018, National Tropical Botanical Garden (NTBG) 2018, Lyon Arboretum 2019, Pahole Rare Plant Facility 2019, Pōhakuloa Training Area (PTA) 2019, Volcano Rare Plant Facility 2019). While *Deparia kaalaana* and *Kadua haupuensis* are considered extinct in the wild, there is propagative material of these species in storage (PEPP 2017, USFWS 2016a).

The State formed the Hawaiʻi Invasive Species Council (HISC) to mitigate introductions of nonnative species, control invasive species, educate the public, and generate awareness that enhances species' conservation. Subgroups of invasive species committees (ISCs) focus on

priority island-specific threats (HISC 2009). The ISCs are voluntary, island-based partnerships that work with government agencies, non-profit organizations, and private businesses and landowners to proactively protect each island from potential invasive species. The ISC's target species that have the potential to severely affect the economy, environment, agriculture, human health, and/or quality of life. Current target species include fast-spreading *Miconia* trees, coqui frogs (*Eleutherodactylus coqui*), and stinging little fire ants (*Wasmannia auropunctata*). In response to the threat of axis deer being transported and released on deer-free islands, the HISC drafted House Bill 2593 to amend House Revised Statute (H.R.S.) 91, which allowed agencies to adopt emergency rules when there is imminent peril to public health, including to livestock and poultry health (BigIslandNow.com 2011; Martin 2011, *in litt*.). This emergency rule became permanent on June 21, 2012, when the bill was enacted into law (State of Hawai‘i 2014). The ISCs have well-developed management plans to address the top threats identified by each of the islands' watershed partnerships. Work done by these committees contributes directly to the conservation of habitats required by the 49 newly listed species.

The Hawai‘i Wildfire Management Organization (HWMO) works with communities throughout the State to implement projects to mitigate wildfire hazards and to protect natural resources (HWMO 2018). The HWMO sponsors community wildfire preparedness workshops, and has conducted wildfire hazard assessments for every community in the State. These assessments provide a more thorough understanding of wildfire hazards that can be addressed by communities, decision makers, fire responders, and natural resource managers. This organization directly supports the conservation of a broad range of habitats throughout the State through preparation and education efforts to minimize destruction of the native habitats by wildfires (HWMO 2018).

2. Summary Conservation Assessment

Overall, populations of these listed species are declining and their ranges restricted. The recovery prognosis for the 34 plant species is modest, as methods have not been developed to overcome all threats, and many threats to listed species are compounded by the number of and interactions of multiple threats. However, there are several species that have populations that are either of sufficient size to allow for successful management or populations can be augmented or created via outplanting. Many of the threats can be addressed by proven management actions such as fencing and controlling ungulates, invasive plants, and predators and herbivores, although implementation and funding is limited. Despite these advances, addressing the lack of pollinators, consequences of small population size, reduced reproductive vigor, and climate change for some plant species may be more challenging.

The recovery prognosis for the band-rumped storm-petrel is unknown, as some nesting locations for this species have only recently been discovered and no active management or population monitoring currently occurs. For the ‘i‘iwi, ongoing native forest management will help sustain suitable habitat in disease-free areas. However, as the climate continues to warm,

these disease-free areas will continue to shrink unless tools to control mosquitos, vectors of avian malaria and avian pox, are developed and used. Research and evaluation of the feasibility of broad-scale mosquito control or elimination are ongoing. The anchialine pool shrimp, *Procaris hawaiana*, is at risk of extirpation due to pollution, nonnative fish introduction, and overuse of its habitat, with little species-specific management to address these threats beyond signage and public education. Little is known about the population size of the species within the limited pools where it remains due to its use of underground habitat, thus recovery prognosis is unknown. Even though no specific conservation measures have been implemented for *Drosophila differens, D. heteroneura, D. mulli, D. neoclavisetae, and D. ochrobasis,* these species benefit from general habitat management actions such as invasive species control. Lack of surveys and sightings of these species makes their recovery prognosis unknown. Management for *Megalagrion nesiotes*, *M. pacificum*, and *M. xanthomelas* is minimal but reintroduction efforts are ongoing for *M. xanthomelas*. *M. nesiotes* is little-known, so the species' recovery prognosis is unknown. Both *M. xanthomelas* and *M. pacificum* are still known from multiple islands and recovery is achievable, however, management of threats is complicated, so their recovery potential is low. Several partnerships and ongoing management activities address threats to the *Hylaeus* species, and research to identify limiting factors could improve their recovery outlook.

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 listed species.

II. Preliminary Recovery Strategy

A. RECOVERY PRIORITY NUMBERS

Recovery priority numbers (RPNs) are assigned to species based on the degree of threat, the potential for recovery, and their status as full species (USFWS 1983a,b) and range from 1c (highest, "c" indicating the potential for conflict with human economic activities) to 18 (lowest). All of the species addressed herein have a high degree of threat to their habitat and continued existence but none has conflict with human economic activities (Table 2, Table 3).

Two plant species, *Haplostachys haplostachya* and *Stenogyne angustifolia*, are assigned recovery priority numbers of 1 and 2 respectively, based on the high degree of threat, high recovery potential, and *H. haplostachya* is the only extant species within its genus. Another plant species, *Pseudognaphalium sandwicensium* var. *molokaiense* is assigned a recovery priority number of 3 based on a high degree of threat, a high potential for recovery with threats that are well understood and easily mitigated, and its taxonomic status as a variety. Twenty-seven plant species, the 4 Hawaiian yellow-faced bees, the *Drosophila* species, the *Megalagrion* species, and the anchialine pool shrimp are assigned a recovery priority number of 5 based on a high degree of threat, a low potential for recovery with threats that are difficult to mitigate, and

their status as a species. Three plant species, *Dryopteris glabra* var. *pusilla*, *Joinvillea ascendens* subsp. *ascendens*, and *Microlepia strigosa* var. *mauiensis*, and the band-rumped storm-petrel are assigned a recovery priority number of 6 based on a high degree of threat, a low potential for recovery with threats that are difficult to mitigate, and their status as subspecies/varieties (and the band-rumped storm-petrel's status as a distinct population segment). Another plant species, *Panicum faurei* var. *carteri*, is assigned a recovery priority number of 9, based on the moderate degree of threat, high potential for recovery, and its status as a variety. The ʻiʻiwi is assigned a recovery priority number of 11, based on a moderate degree of threat, a low potential for recovery with threats that are difficult to mitigate, and its status as a species.

B. RECOVERY GOAL AND OBJECTIVES

The goal of the recovery plan is to establish recovery actions necessary to ensure the long-term survival of these species and to control or reduce the threats to the species to the extent that they no longer require protection under the Act. These are conservation-reliant species, which will require continual management. Although subject to change, full recovery of these species is currently envisioned as follows: viable populations will persist in protected and managed habitat within each of the species' historical ranges as well as in additional areas as needed due to climate change-related shifts in suitable habitat. Threats to the species, primarily habitat loss and degradation and predation by nonnative species, will need to be managed to ensure species viability and persistence into the future. In keeping with the island-wide approach to recovery for these species, the Service also will develop recovery objectives, allowing for adaptive management, for each management unit.

C. INITIAL RECOVERY ACTION PLAN:

The goal of the multi-island species and Kauai species recovery plans will be to reverse population declines and increase the range of these species. The objectives of the recovery plans will be to:

1. Protect ecosystems and control threats.
   - 1.1. Identify and survey extant populations of all species and the habitats in which they occur.
   - 1.2. Develop fine-scale microclimate models to identify suitable habitat based on existing and historical ranges and determine potential recovery areas with suitable projected climate conditions.
   - 1.3. Identify species-specific areas within each habitat necessary for recovery and delineate management units.
   - 1.4. Ensure long-term protection of management units.

1.4.1. Identify threats specific to 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 invasive plant-free status.

1.4.4. Develop and implement a rodent control program within management units; for habitats where feasible (*e.g.*, offshore islets) or where rodent exclusion fencing can be installed, implement rodent eradication programs.

1.4.5. Develop and initiate management unit-specific water management plans to reduce the likelihood of modification and destruction of aquatic features.

1.4.6. Provide wildfire protection as necessary.

1.4.6.1. Develop management unit-specific fire management plans and infrastructure, and initiate management actions to reduce the likelihood of fire, especially in dry and mesic habitats.

1.4.6.2. Assess the need for fire management plans in wet habitats affected by climate change.

1.4.7. Protect management units from human disturbance as necessary.

1.4.8. Control other threats as appropriate.

2. Control species-specific threats.

2.1. Develop and implement control of mosquitoes that transmit avian disease.

2.2. Implement control for rats and update and improve as new technology becomes available.

2.3. Implement control for feral cats and update and improve as new technology becomes available.

2.4. Implement control for barn owls and update and improve as new technology becomes available.

2.5. Implement control for mongoose and update and improve as new technology becomes available.

2.6. Develop and implement control for nonnative fish in anchialine pools.

2.7. Implement control for bullfrogs and update and improve as new technology becomes available.

2.8. Develop and implement control for Jackson's chameleon.

2.9. Implement control for slugs and nonnative snails and update and improve as new technology becomes available.

2.10. Develop and implement control for black twig borer (*Xylosandrus compactus*).

2.11. Develop and implement control for invasive ants (big-headed ant [*Pheidole megacephala*], long-legged ant [*Solenopsis papuana*], and tropical fire ant [*S. geminate*]).

2.12. Develop and implement control for the western yellow-jacket wasp (*Vespula pensylvanica*).

2.13. Develop and implement methods to prevent humans from removing *Procaris hawaiana* from anchialine pools for personal and commercial use.

2.14. Control other species-specific threats as appropriate.

3. Expand existing wild populations, and establish new populations, to increase resiliency.

3.1. Select species for reintroduction and populations for augmentation.

3.2. Identify habitat and management units appropriate for reintroduction using microclimate models.

3.3. Prepare reintroduction and augmentation sites by addressing threats with appropriate control methods.

3.4. Propagate genetically appropriate plants for reintroduction and augmentation and store spores, seeds, and propagules for future use.

3.5. Release or translocate picture-wing flies, damselflies, and yellow-faced bees and reintroduce plants that are genetically appropriate at prepared management units.

4. Control new threats before they become widespread.

4.1. Facilitate surveys, focused on likely source areas (*e.g.*, airports), and control incipient (newly discovered) pest or invasive species prior to their dispersal to management units.

4.2. Facilitate improved biosecurity to minimize the probability of new nonnative species from becoming established in Hawai‘i.

5. Facilitate and conduct research essential to the restoration of habitat and for the recovery and management of species, as needed.

5.1. Facilitate and conduct studies on the range, demography, and dispersal of each species.

5.2. Conduct research to confirm the larval stage host plants for *Drosophila mulli* and *D. neoclavisetae.*

5.3. Study the natural recruitment, range, and fecundity of *Drosophila* host plants.

5.4. Facilitate and conduct Population Viability Analyses (PVAs) for each species as appropriate.

5.5. Facilitate and conduct studies on management and control of nonnative invasive species.

5.6. Facilitate and conduct studies on effective propagation and reintroduction methods for those species where natural regeneration is insufficient to achieve recovery.

5.7. Facilitate and conduct studies on effective methods for long-term spore and seed storage.

6. Develop and implement a detailed monitoring plan for each species and its associated habitat.
7. Develop downlisting and delisting criteria specific to species, and their habitat, as necessary, to validate recovery objectives.
8. Partner with key stakeholders to develop and accomplish above objectives.
9. For all recovery actions, evaluate management and research results and implement adaptive management as necessary.

D. RECOVERY ACTIONS

The recovery effort for these 49 species should build on the conservation and monitoring efforts described above. Specific actions that should be started early in the recovery planning process include:

- Confirm the distribution, status, and assess the potential future distribution of existing habitat and determine the most suitable 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 and initiate control of habitat-modifying threats, such as ungulates and invasive nonnative plants, within the highest priority management units.
- Prevent the influx of new invasive species into recovery areas. Secure funding for and increase the efforts of the Invasive Species Council to improve border security.
- Prioritize research that provides information and tools to ameliorate threats to habitats and species, as well as provide new techniques for captive propagation and reintroduction.
- Secure propagules and other biological materials for captive propagation, translocation, and for genetic storage.
- Increase outreach efforts and coordination with State agencies and private landowners regarding habitat and species conservation. Promote opportunities to assist in the recovery of these species through habitat conservation plans, safe harbor agreements, Federal action agency section 7(a)(1) and 7(a)(2) consultation obligations under the Act, and through various conservation partnerships funded by State and Federal agencies and private organizations.

III. Preplanning Decisions

A. PLANNING APPROACH

A multi-species recovery plan for the 34 plants (8 of which are endemic to Kaua‘i) and 15 animal species will be prepared pursuant to section 4(f) of the Endangered Species Act. The Pacific Islands Fish and Wildlife Office will prepare the recovery plan for Regional Director approval.

B. INFORMATION MANAGEMENT

All information relevant to the recovery of these 49 species 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 recovery planning and implementation for these species.

C. RECOVERY PLAN SCHEDULE

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

D. STAKEHOLDER INVOLVEMENT

Key stakeholders:

- Conservation organizations,
- Local entities and County, State, and Federal agencies that own or manage lands currently or historically occupied by any of the 49 listed species or with habitat types suitable for establishing new populations,
- Native Hawaiian groups,
- Outdoor sports and recreation organizations,
- Private landowners that own property currently or historically occupied by any of the 39 newly listed species or with habitat suitable for establishing new populations,
- State of Hawai‘i Department of Lands and Natural Resources, Division of Forestry and Wildlife staff,
- U.S. Geological Survey, Biological Resources Discipline staff, and
- University of Hawai‘i and other academic researchers.

E. STAKEHOLDER INVOLVEMENT STRATEGY

Landowners and land managers that may be affected by the listing and recovery of the 49 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 these species as well as other 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 to 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, in 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 will be afforded an opportunity to review and comment on the draft recovery plan as per the ESA. Strong working relationships with experts and stakeholders will be developed and maintained.

Approved:

NANETTE SETO Digitally signed by NANETTE SETO Date: 2020.07.30 07:49:23 -07'00'

Acting Regional Director

July 30, 2020

Date

Citation:

U.S. Fish and Wildlife Service. 2020. Recovery Outline for Hawaiian Multi-Island Species. Portland, Oregon. 36 pp.

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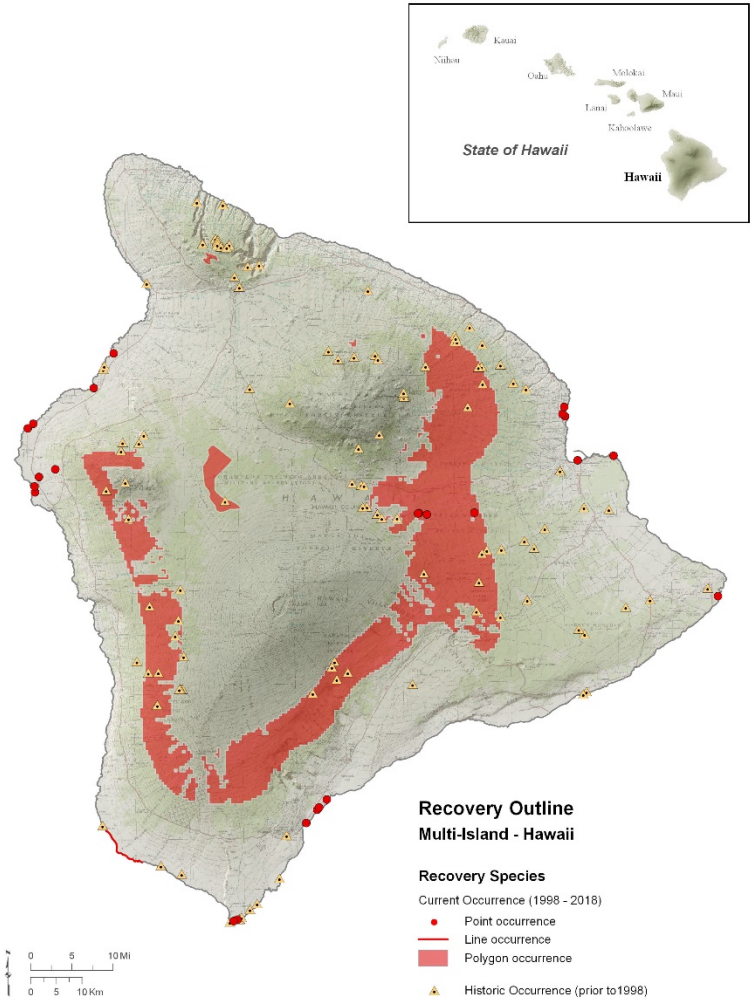
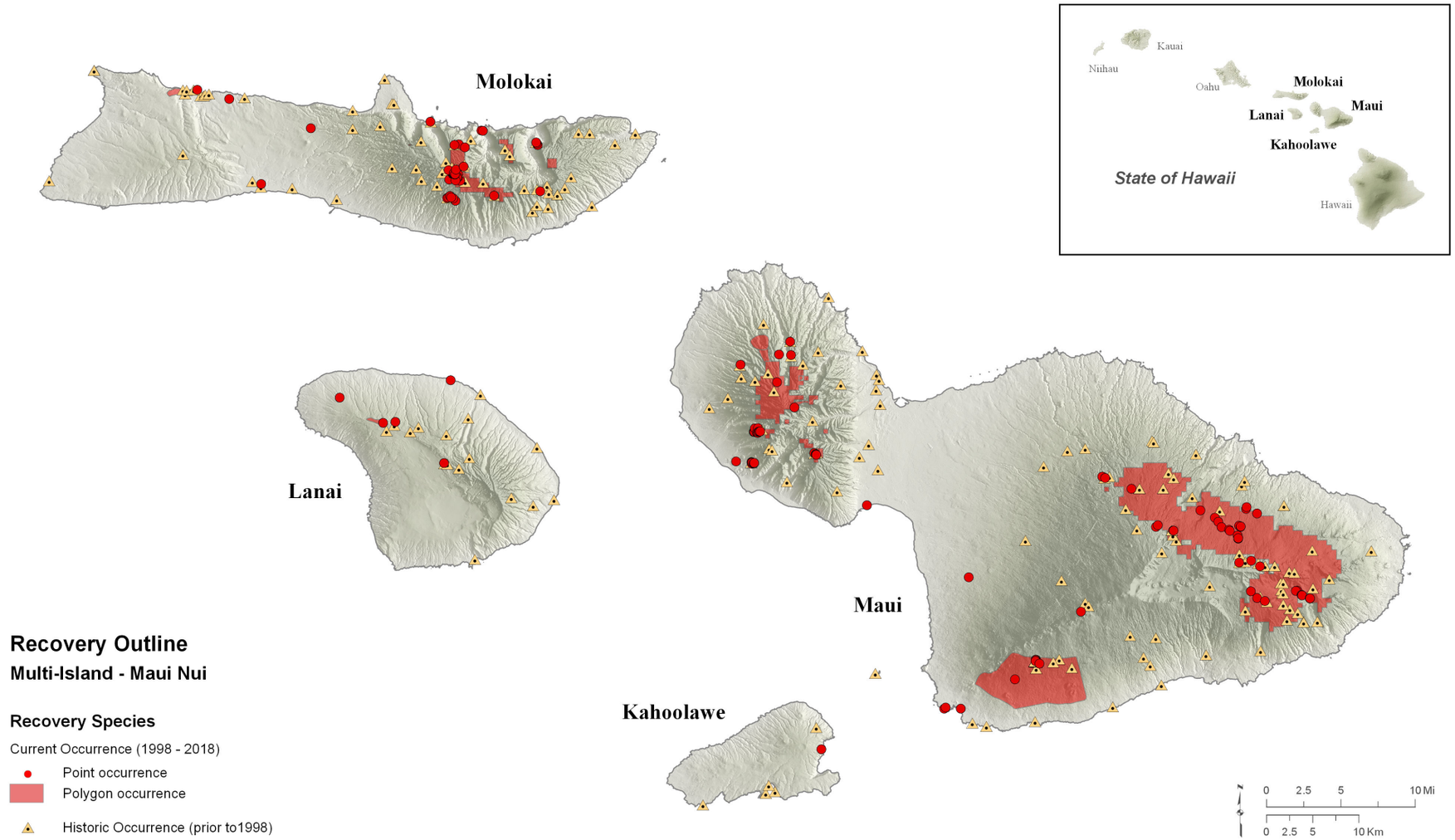
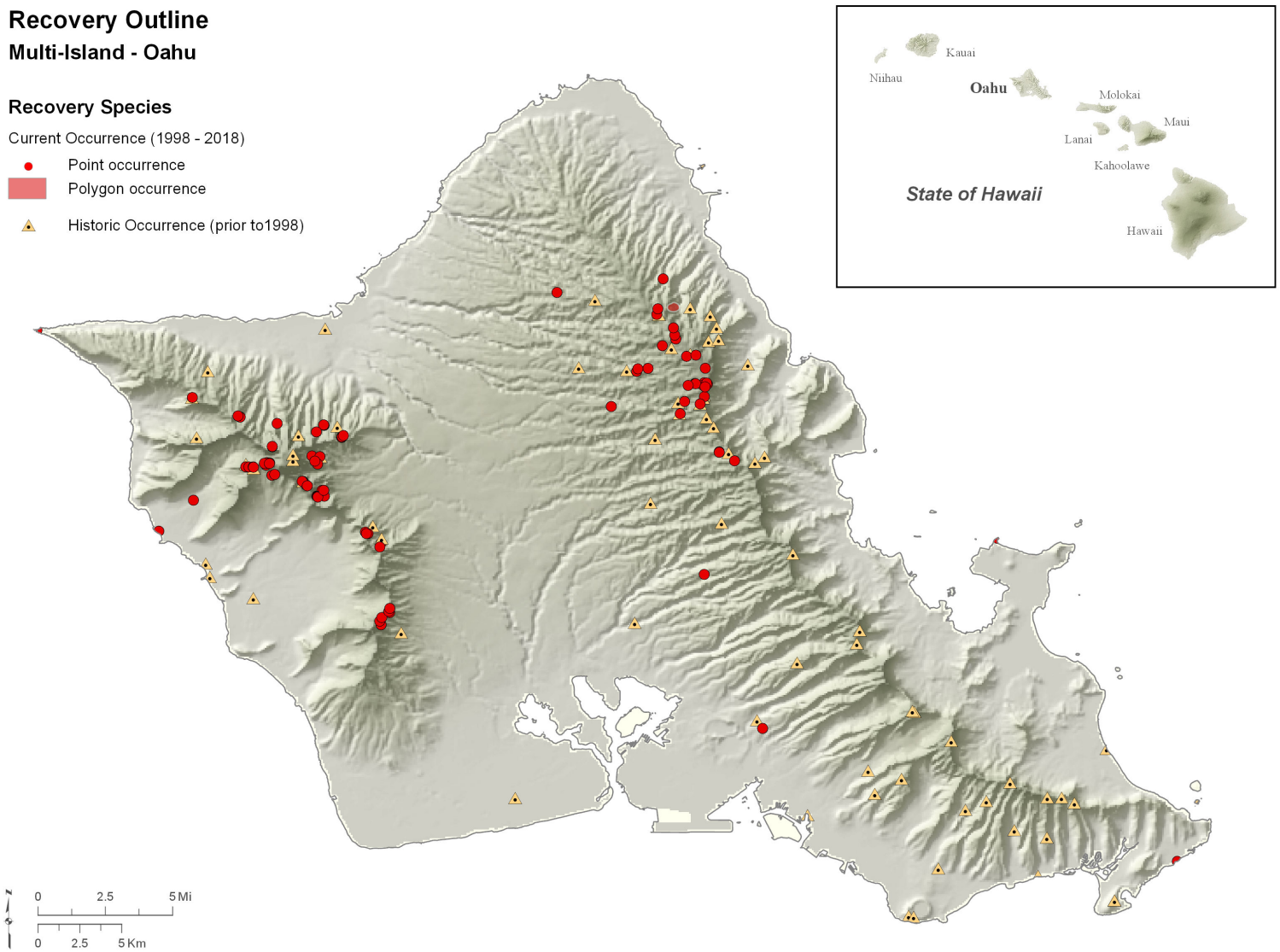
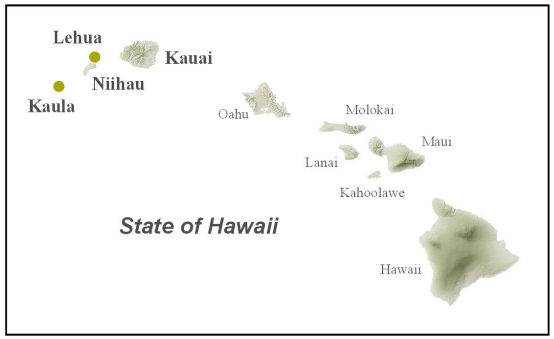
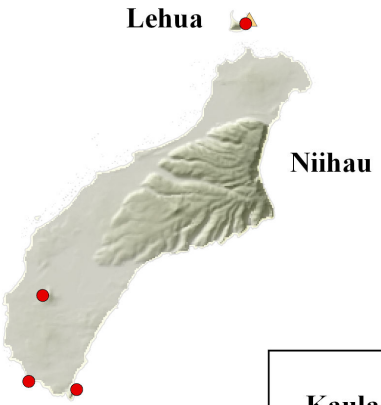
Appendix—Maps

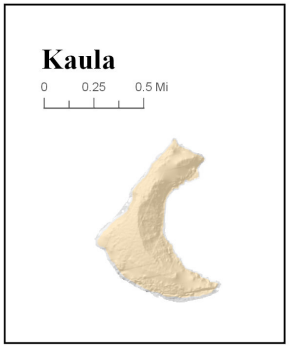


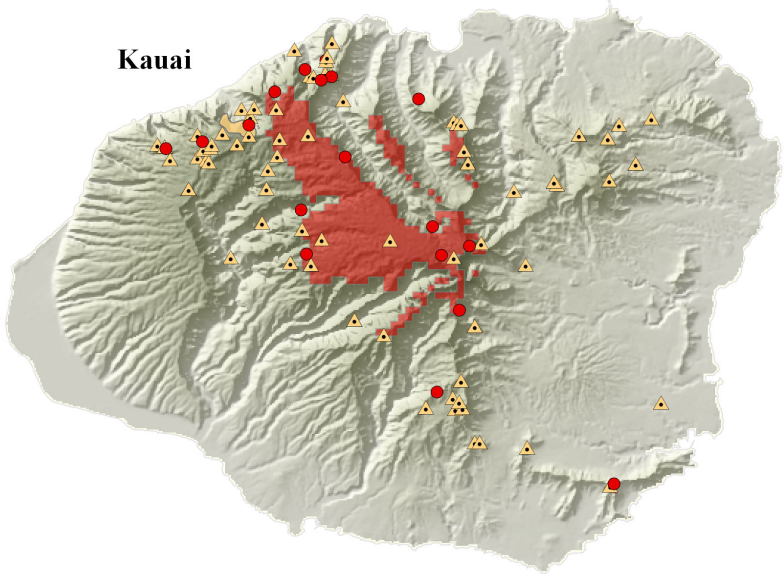

Molokai
Lanai
Maui
Kahoolawe
Kauai
Niihau
Oahu
Molokai
Maui
Lanai
Kahoolawe
State of Hawaii
Hawaii
Recovery Outline
Multi-Island - Maui Nui
Recovery Species
Current Occurrence (1998 - 2018)
Point occurrence
Polygon occurrence
Historic Occurrence (prior to1998)
0 2.5 5 10 Mi
0 2.5 5 10 Km


Recovery Outline
Multi-Island - Oahu
Recovery Species
Current Occurrence (1998 - 2018)
Point occurrence
Polygon occurrence
Historic Occurrence (prior to1998)
Kauai
Niihau
Oahu
Molokai
Maui
Lanai
Kahoolawe
State of Hawaii
Hawaii
0
2.5
5 Mi
0
2.5
5 Km









Recovery Outline

Multi-Island - Kauai, Niihau, Lehu, Kaula

Recovery Species

Current Occurrence (1998 - 2018)

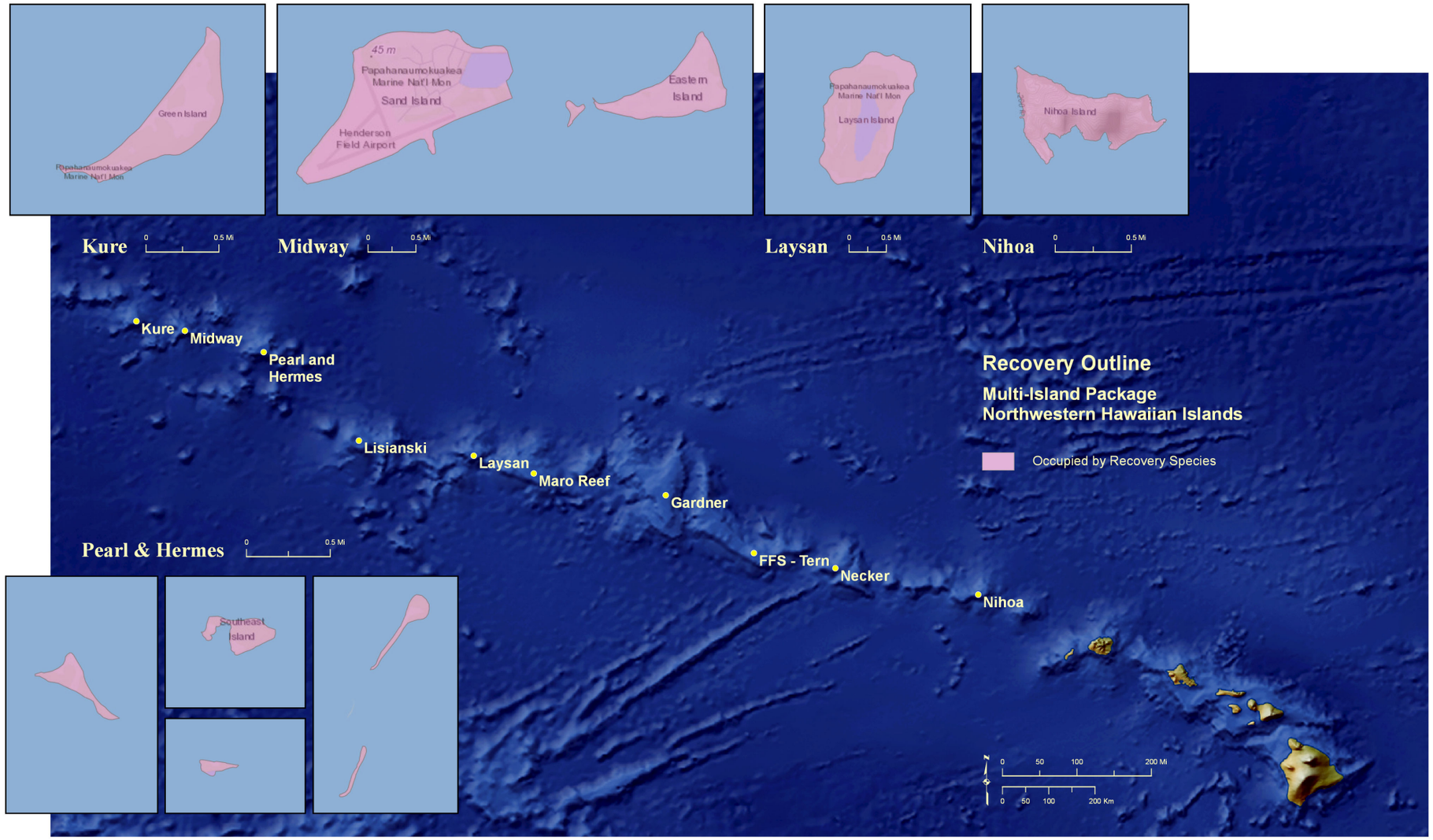
- Point occurrence
- Polygon occurrence

Historic Occurrence (prior to 1998)

- Point occurrence
- Polygon occurrence

0 5 10 Mi

0 5 10 Km


Green Island
Papahanaumokuakea Marine Nat'l Mon
Kure
0
0.5 Mi
45 m
Papahanaumokuakea Marine Nat'l Mon
Sand Island
Henderson Field Airport
Eastern Island
Midway
Papahanaumokuakea Marine Nat'l Mon
Laysan Island
Laysan
Nihoa Island
Nihoa
Kure
Midway
Pearl and Hermes
Lisianski
Laysan
Maro Reef
Gardner
FFS - Tern
Necker
Nihoa
Recovery Outline
Multi-Island Package
Northwestern Hawaiian Islands
Occupied by Recovery Species
Pearl & Hermes
Southeast Island
0
50
100
200 Mi
200 Km