



Technical Report HCSU-025

RARE AND ENDANGERED SPECIES OF HAWAI'I VOLCANOES NATIONAL PARK

Endangered, Threatened, and Rare Animal, Plant, and Community Handbook

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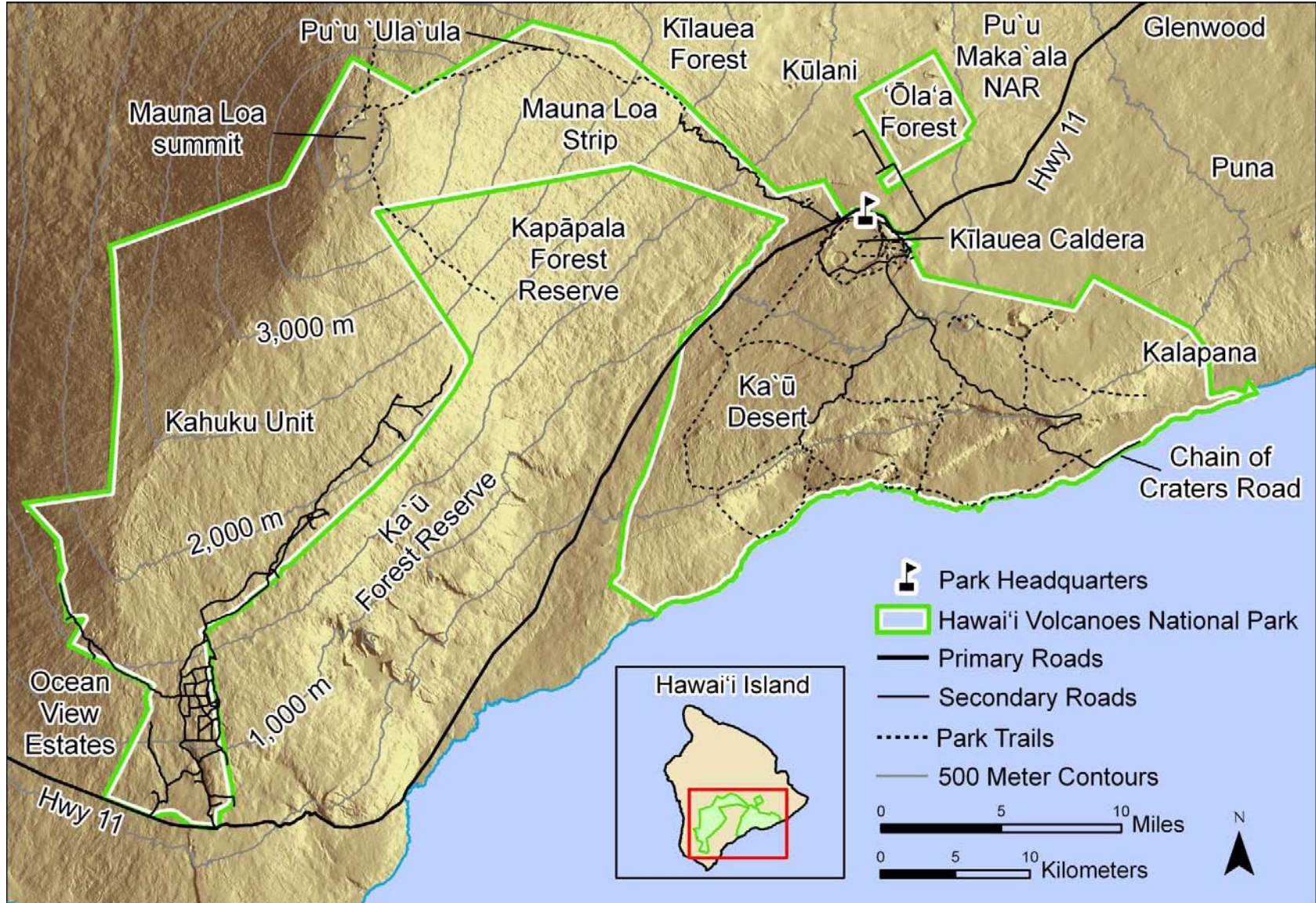


Figure 1. Hawai'i Volcanoes National Park

Introduction

Hawai`i Volcanoes National Park (HAVO) is the largest area in the State of Hawai`i protected for its geology and landscapes and its native flora and fauna. The park covers approximately 135,000 hectares or 333,000 acres in all. These lands stretch from the seacoast of Kīlauea Volcano to far above timberline on the summit of Mauna Loa (Figure 1). This vast area includes expanses of forests, woodlands, shrublands, and barren lava flows that represent an array of native ecosystems. Contained within these communities are a great many species of rare animals and plants, most of them unique to the island of Hawai`i, and some of them surviving only in the park. These are the biological treasures of Hawai`i Volcanoes National Park.

Our book is a guide to all animal and plant species in HAVO that are specially recognized as endangered species in the general sense. (The official designations at four levels and the unofficial designation of species of concern are explained later.) There are 23 such animal species and 71 plant species covered in the handbook, including six species planted in HAVO but not naturally occurring. In addition, we describe seven rare communities.

In some cases, HAVO offers the best opportunity to save these species and communities from extinction. Increasingly, the park has attempted to restore rare populations by conducting surveys to locate them, controlling threats such as feral livestock, and bolstering existing populations or creating new ones by planting nursery stock. To aid such efforts, our original intent was to publish an identification guide for researchers and field management personnel. Particularly, we wanted to familiarize the reader with the many rare plant species which otherwise are known mainly from the technical literature. Because we soon came to realize that this handbook would be useful to a much larger, general readership, our aim is to make this information available to anyone interested in endangered animals and plants at Hawai`i Volcanoes National Park.

Ecological Context

To understand the ecological setting for rare and endangered animals and plants in HAVO, it is important to first gain familiarity with the range of habitat types in the park. Within HAVO, there are numerous vegetation communities that we broadly group into seven ecological zones. These zones are the coastal strand and dry coastal lowlands; lowland wet forest remnants; dry to mesic mid-elevation woodlands, including the sparsely vegetated **Ka`ū Desert; montane wet forest; montane mesic forests** of high biodiversity and less diverse montane dry forests; subalpine woodlands and shrublands; and alpine aeolian desert. Lava flows in early successional stages may be found in any of these zones. Every major ecological zone of the park supports rare animals, plants, or communities.

Realizing that rare animals and plants live in communities made up of common species, what plants are the foundation species within the seven ecological zones? Many of these plants will already be familiar to residents of Hawai`i. Coastal strand communities often contain the indigenous shrub naupaka kahakai (*Scaevola taccada*). The dry coastal lowlands are dominated by alien grasses but may also support native shrubs, particularly `a`ali`i (*Dodonaea viscosa*) and pūkiawe (*Leptecophylla tameiameia*). Dry to mesic

woodlands of `ōhi`a lehua trees (*Metrosideros polymorpha*) are found in both lowland and montane zones; these often have a ground cover of alien grasses. Lowland dry and mesic forests are composed of `ōhi`a lehua and lama trees (*Diospyros sandwicensis*), often mixed with native shrubs. Both lowland and montane wet forests are characterized by the dominant tree `ōhi`a lehua; such forests often have an understory of the native tree `ōlapa (*Cheirodendron trigynum*), kāwa`u or Hawaiian holly (*Ilex anomala*), kōlea lau nui (*Myrsine lessertiana*), and pilo (*Coprosma* spp.). Tree ferns or hāpu`u (*Cibotium* spp.) are prominent in wet forests of the park. Diverse montane mesic forests have as their dominant trees koa (*Acacia koa*) and mānele or soapberry (*Sapindus saponaria*) along with the ubiquitous `ōhi`a lehua. Less diverse montane dry and mesic forests typically have koa as the dominant tree, often with `a`ali`i and trees such as māmane (*Sophora chrysophylla*) and naio (*Myoporum sandwicense*). Subalpine woodlands are composed of `ōhi`a lehua and māmane, and subalpine shrublands usually have scattered `ōhi`a trees among the dominant shrubs pūkiawe, `a`ali`i, and `ōhelo (*Vaccinium reticulatum*). Alpine aeolian deserts of the high mountain summits have little vegetation other than scattered pūkiawe and `ōhelo shrubs, along with mosses and lichens. These zones rarely have sharp boundaries but instead grade from one to the next. Furthermore, lava flows of different ages support vegetation in corresponding stages of successional development and so create a mosaic effect of vegetation communities.

Why are endangered animals and plants rare in the park?

Ecological communities within HAVO, and especially outside the park, have changed much since settlement by people, mainly because of the spread of nonnative species. While some species of native animals and plants may always have been uncommon, certainly most are endangered now because of modern threats. Threats to many of the rare animals and plants and their habitats include feral ungulates, nonnative rodents, alien insects and other invertebrates, alien plant invaders, and wildfire. Domestic cattle (*Bos taurus*) were formerly present in sections of HAVO, and they remain in areas adjacent to the park. Cattle were removed from the national park because they consume native vegetation and can convert forest and shrublands into communities of alien grasses (Baldwin and Fagerlund 1943). Feral pigs (*Sus scrofa scrofa*) impact unprotected wet forests with their habit of digging in the soil and trampling undergrowth (Stone 1985). Water collects in the hollows that pigs chew in tree fern trunks, creating breeding pools for mosquitoes (*Culex quinquefasciatus*) that transmit diseases among birds (Goff and van Riper 1980, Atkinson and LaPointe 2009). Feral goats (*Capra hircus*), feral sheep (*Ovis aries*), and mouflon sheep (*O. gmelini musimon*) browse and graze directly on plants and reduce the cover of trees and shrubs favored as food plants (Stone 1985). HAVO managers have greatly reduced the populations of these destructive ungulates within park borders.

Smaller animals also have an impact on rare native species. Feral cats (*Felis sylvestris catus*), the small Indian mongoose (*Herpestes auropunctatus*), and barn owls (*Tyto alba*) prey on native birds. Rodents, including the black rat (*Rattus rattus*), Polynesian rat (*R. exulans*), and the house mouse (*Mus musculus*) are seed predators of many plants and have been implicated as predators of native birds and their eggs (Lindsey *et al.* 2009). The western yellowjacket (*Vespula pensylvanica*) invaded the island of Hawai`i in the 1970s and has been found to prey on many native insects (Gambino 1992). The two-spotted leafhopper (*Sophonia rufofascia*) arrived in Hawai`i Island only in 1989 and it is known to

attack hundreds of plant species, including many native plants listed as endangered (Lenz *et al.* 2006). New insects and pathogens arrive in the Hawaiian Islands with high frequency (Eldredge and Evenhuis 2003), and a few of them have become pests with the capability of attacking native plant species. Two recent examples are the *Erythrina* gall wasp (*Quadrastichus erythrinae*) and **`ōhi`a rust** (*Puccinia psidii*; Loope and Kraus 2009).

Many alien plants have invaded the habitats of rare animals and plants in HAVO. Fire-adapted alien grasses have invaded the coastal lowlands and both lowland and montane **`ōhi`a lehua woodlands; grass species that are common in such areas include bush beardgrass** (*Schizachyrium condensatum*), broomsedge (*Andropogon virginicus*), molasses grass (*Melinis minutiflora*), and Natal red-top (*M. repens*; Smith and Tunison 1994). Wildfire has become more frequent in HAVO since the establishment of alien grasses, and few native plant species respond positively to fire (Tunison, Leialoha *et al.* 1994; Tunison *et al.* 1995). Firetree or faya (*Morella faya*) **is a particular threat to `ōhi`a lehua woodlands** but may also invade wet forests. Fountain grass (*Pennisetum setaceum*) is a potential invader of dry vegetation in HAVO but has been controlled parkwide. Remnant lowland dry-to-mesic forests are impacted by alien grasses as well as lantana (*Lantana camara*) and Asian swordfern (*Nephrolepis brownii*). Some of the worst invaders of wet and mesic forests are strawberry guava (*Psidium cattleianum*), yellow Himalayan raspberry (*Rubus ellipticus* var. *obcordatus*), **kāhili ginger** (*Hedychium gardnerianum*), banana poka (*Passiflora tarminiana*), and palmgrass (*Setaria palmifolia*; Cuddihy and Stone 1990). Montane dry and mesic forests and the subalpine woodlands have been invaded by escaped pasture grasses such as meadow rice grass (*Ehrharta stipoides*), dallis grass (*Paspalum dilatatum*), Vasey grass (*P. urvillei*), and velvet grass (*Holcus lanatus*). Common mullein (*Verbascum thapsus*), a large biennial herb, is a recent threat to upland vegetation.

What is being done to protect rare plants and animals in the park?

Starting in the 1970s, HAVO began large-scale fencing of the park boundaries and management units to exclude feral goats and pigs. Park boundaries adjacent to cattle ranches had existing fencing upgraded. Within about 15 years HAVO had eliminated feral goats from within the park (Stone *et al.* 1992), but removal of feral pigs required greater time and effort. By the 1990s feral pigs had been excluded from almost 80% of HAVO (Katahira *et al.* 1993) or about a third of the park lands that supported pigs (Tunison 1992). Additional pig-free enclosures were built in the 1990s and 2000s, and feral pig numbers are reduced in other areas of HAVO that are not pig-free. Mouflon sheep invaded the original unit of HAVO in the 1990s and were well established at Kahuku when the National Park Service acquired the Kahuku Ranch in 2003 (Hess *et al.* 2006). Exclusion of mouflon sheep has required modifications of existing fences, and complete removal of the animals has proven difficult to achieve. However, mouflon numbers are being reduced at the Kahuku Unit, and these sheep have been effectively excluded from the original section of the park below a fence in the alpine zone.

It has not been possible to remove nonnative predators of birds on a large scale owing to technical, legal, and ethical constraints. However, some small-scale projects seem **promising. Park managers remove feral cats and small Indian mongooses from nēnē** breeding areas (Rave *et al.* 2005). Predators are also trapped at selected Hawaiian petrel colonies to protect these seabirds. At the time of writing, HAVO was seeking funding to

construct a predator-proof fence around the **park's known** petrel colony (D. Hu, pers. comm.). Research to control rats by means of registered baits has been conducted in the park (U.S. Geological Survey, unpublished data). Although rat control proved to be successful and effective on study plots, these techniques have not yet been approved or implemented for rodent control on a large scale.

Eventhough there have been studies on control methods for the alien western yellowjacket (Gambino and Loope 1992, Spurr and Foote 2000), no large-scale efforts to reduce these insects have been undertaken in HAVO. Yellowjacket control efforts have been directed at areas used by humans in response to visitors being stung. No control method is available for the two-spotted leaf hopper, or for most other insects that attack native plants. Biocontrol research has been successfully carried out for some insect pests of native plants (e.g., the *Erythrina* gall wasp (Heu *et al.* 2006)) and is planned for others (P. Conant, pers. comm.). Alien slugs have been recently recognized as seedling predators of native plants, particularly those with soft and fleshy tissue (Joe and Daehler 2008). Previous research has documented the abundance of large alien slugs in wet forests of HAVO (Dean 2006), but no method of large-scale slug reduction is currently known. Some research has been accomplished on mosquitoes in HAVO, and larval habitat reduction has been recommended to reduce mosquito numbers and the potential for disease transmission to native birds (Reiter and LaPointe 2009).

Large-scale, systematic alien plant control began in HAVO with attempts to eradicate fountain grass and faya (firetree) in the 1960s and 1970s (Tunison *et al.* 1994; Lutzow-Felling *et al.* 1995). When complete eradication was deemed infeasible because of rapid spread and the continued invasion of other alien plant species, a strategy of containment of fountain grass, control of the most invasive alien plants in Special Ecological Areas (SEAs), and removal of newly established incipient invaders was adopted in 1985 (Tunison 1992). Special Ecological Areas are management units selected for their representativeness, manageability, native species diversity, presence of rare species, and value for research and interpretation (Tunison and Stone 1992). Following this three-part management strategy, more than 20 highly invasive alien plant species have been controlled in 27 SEAs of HAVO (Loh and Tunison 2009), and more than 40 localized alien plant species have been treated throughout the park (Tunison and Zimmer 1992). No techniques currently exist for large-scale control of most of the widespread alien grasses that have become established throughout the HAVO lowlands and other dry community types (Smith 1985).

Reintroduction of endangered plant species is widely recognized as part of a conservation strategy for Hawaiian flora (Mehrhoff 1996). A planting program for native trees was begun in 1924 at HAVO, but species selected were not always native to the park (Smith 1977), and a comprehensive understanding of the **park's natural flora was not achieved until later** surveys and publication of plant checklists (Fagerlund and Mitchell 1944; Fosberg 1966, 1975; Higashino *et al.* 1988). Planting activities continued sporadically in HAVO, and efforts to plant native species were most intense during the 1940s and 1950s (Morris 1967). After the creation of a Resources Management Division at HAVO and the publication of lists of endangered plant species in Hawai`i (Fosberg and Herbst 1975, U. S. Fish and Wildlife Service 1976), the **park's planting program became focused on endangered plant species** (Smith 1977) and restoration of the species-poor, degraded coastal lowlands (Smith 1980). With the adoption of a SEA approach to feral ungulate removal and alien plant control

(Tunison *et al.* 1986), the emphasis of the planting program became restoration of communities rather than species, and restoration efforts included depleted common native species and community dominants that created a matrix of trees. In 1998, the Natural Resources Management Division began a decade-long project to stabilize rare plant populations in the park by re-introduction or augmentation of more than 80 rare or depleted plant species (Belfield *et al.* 2011). Rare plant restoration continues in HAVO with the implementation of projects to restore missing or uncommon native species to specific sites, such as Kahuku (McDaniel *et al.* 2008), **the East Rift of Kīlauea (Loh 2008a)**, and **the lower Mauna Loa Strip (Loh 2008b)**. The success of current and past planting projects will only be completely appreciated after continued monitoring and the passage of time.

Format

The structure of this handbook of rare animals, plants, and communities follows that of a field guide to sensitive plants, animals, and communities produced for Lake Mead National Recreational Area (NRA) by Bryan C. Moore and Jeanne S. Sealove of National Park Service (NPS) and Teri A. Knight of The Nature Conservancy (TNC) (Moore *et al.* 1993). The scope of the current HAVO handbook differs from that of Lake Mead NRA in the larger number of listed threatened and endangered plant and bird species.

Species and communities included in the handbook

Species officially listed as endangered or threatened by the federal and state governments are treated, as are those that are proposed or candidates for endangered status. Species of concern, a new government designation for rare organisms not yet considered endangered, are also covered in the current handbook. Six plant species introduced to HAVO as plantings, but not naturally occurring, are described with accounts in the handbook. The HAVO handbook includes a list of five extinct bird species that were formerly found within the area now included in the national park, but these species are not described in accounts. Plant and invertebrate species that have been extirpated from the park but survive elsewhere in the islands are included in the handbook with the hope that they may someday be re-introduced. (There are no vertebrate animals missing from the park that exist elsewhere.) Natural communities included in the handbook are those considered globally imperiled or rare by the Hawai`i Natural Heritage Program, formerly of The Nature Conservancy and now part of the University of Hawai`i at Mānoa Center for Conservation Research and Training. An additional plant community formerly considered rare but now subsumed into a more common vegetation type has also been included, as has a volcanic fumarole community listed with uncertain status.

Organization of the handbook

The handbook is divided into three sections: animals (including both vertebrates and invertebrates), vascular plants, and natural communities (primarily plant communities). Each section begins with a list of the rare species, including common name, scientific name, and current status. This list is followed by species accounts with a description of the animal, plant, or community, its distribution in the state and park, and information on habitat, habits (for animals), similar species, threats, management strategies, and, in the case of plants, known cultural uses. For plants, detailed descriptions and information on

distribution in the Hawaiian Islands are taken from Wagner *et al.* (1999) except where other authors are cited. Remarks contain information that did not fit in other categories. Place names used in the text are shown on Figure 2 and listed in Table 1. Each species account is preceded by a photograph, when available, and a HAVO distribution map. Photographs were not found for a possibly extinct plant species and two others with limited or unknown distributions in HAVO. Species accounts of birds are arranged as they are listed in The **American Ornithologists' Union (AOU) Checklist of North American Birds (2010)**. Flowering plants are listed and accounts are arranged as the species are treated in Wagner *et al.* (1999) within their taxonomic class (dicots or monocots) and family; within families, the species are listed alphabetically by scientific name. Ferns precede flowering plants and are listed alphabetically by their family according to Palmer (2003). Community accounts are arranged as the communities occur from the coast to the subalpine zone with dry communities preceding mesic and wet communities.

The common and scientific names of the rare animal or plant are given at the beginning of each account. Subsequently, the common name is used within the account except where the scientific name is needed to reduce confusion among multiple species of a genus or when there is no known common name. Common names are used for other animals and plants in species accounts; scientific names for these organisms are provided in an Appendix. **Exceptions include the use of scientific names in the "Similar Species" section** of accounts to avoid confusion between related species with the same common name. Hawaiian names of birds are taken from Pyle (2002). Nomenclature of mammals follows Tomich (1986). Names and families of insects are as listed in Nishida (2002). Nomenclature of flowering plants is derived from Wagner *et al.* (1999) and a later supplement (Wagner and Herbst 2003). Scientific names and many common names of ferns are from Palmer (2003). In the few cases where plants had no common name, an English name based on a translation of the scientific name has been provided. Common names of plants and animals are not capitalized except when a component of the name is derived from the proper name of a person or place.

Measurements are expressed in the metric system, following international usage. The only exceptions are elevation and area, where the elevation in meters and area in hectares are followed by their equivalents in feet and acres; this was done because many topographic maps in wide use have contours in English units. Abbreviations used in measurements are mm for millimeters, cm for centimeters, m for meters, km for kilometers, ha for hectares, ac for acres, g for grams, and ft for feet.






Data and map symbols

Bird locality information was extracted from past and recent bird surveys produced by the National Park Service Inventory and Monitoring Program and by the U.S. Geological Survey Hawai'i Forest Bird Database (Gorresen *et al.* 2005, 2007, 2008, 2009; Turner *et al.* 2006; Tweed *et al.* 2007; Camp *et al.* 2009), as well as historical bird accounts compiled by Winston Banko of the U.S. Fish and Wildlife Service (Banko and Banko 1980; Banko 1984a, 1984b, 1986). Locality information for other animals is based on survey data supplied by park biologists and other researchers. Some of this information is available in reports as cited in the species accounts. Information on rare plants in HAVO is taken from past checklists and inventories, as well as unpublished rare plant packets and published technical

reports. Specimen labels from the HAVO Natural History Collection and a database of rare plant specimens from the park in the Bishop Museum Herbarium provided much locality information on both extant and extirpated species.

Distribution maps presented here do not display great precision, but are intended to provide general locality information for rare species. Symbols on the rare bird maps identify sightings of species since about 1976, the beginning of the Hawai`i Forest Bird Survey (Scott *et al.* 1986). For invertebrates, mapped occurrences are based on specimens and observations from surveys. For plant species, a map symbol may represent a single plant or a population. For both plants and animals, red circles or dots are species currently extant in HAVO and blue circles are historical records (Table 2). Any species not verified as present in the park for 25 years has been treated as historical. For plants, recent and past plantings with sufficiently detailed locality information are mapped with square symbols. If plantings are known to persist, the square symbol is red; if sites have been revisited without locating extant plants, the symbols are blue and considered historical. In a few cases, the success of early plantings is unknown and they are treated as historical. Information on numbers and localities of plantings in HAVO was derived from unpublished reports found in the park library and the files of the Natural Resources Management Division. Reports by David Morris (1967) and N. Chris Zimmer (unpublished 1982–83) were particularly useful. Recent planting numbers, localities, and success rates were taken from a report in preparation (Belfield *et al.* 2011) and implementation plans in the files of the Natural Resources Management Division and were supplemented with personal communications from NPS HAVO staff. For birds, mammals, and some plants, species with large ranges are mapped with polygons. Absence of symbols on maps does not mean that rare species are not present; many areas of the park are unsurveyed.

Table 1. Explanation of Symbols Used on Species Distribution Maps.

Symbol	Name	Description
	Red circle	Extant natural population or individual
	Blue circle	Historical population or individual (>25 years ago)
	Red square	Extant planting
	Blue square	Historical planting, not persisting or unknown
	Orange polygon	Current distribution in HAVO

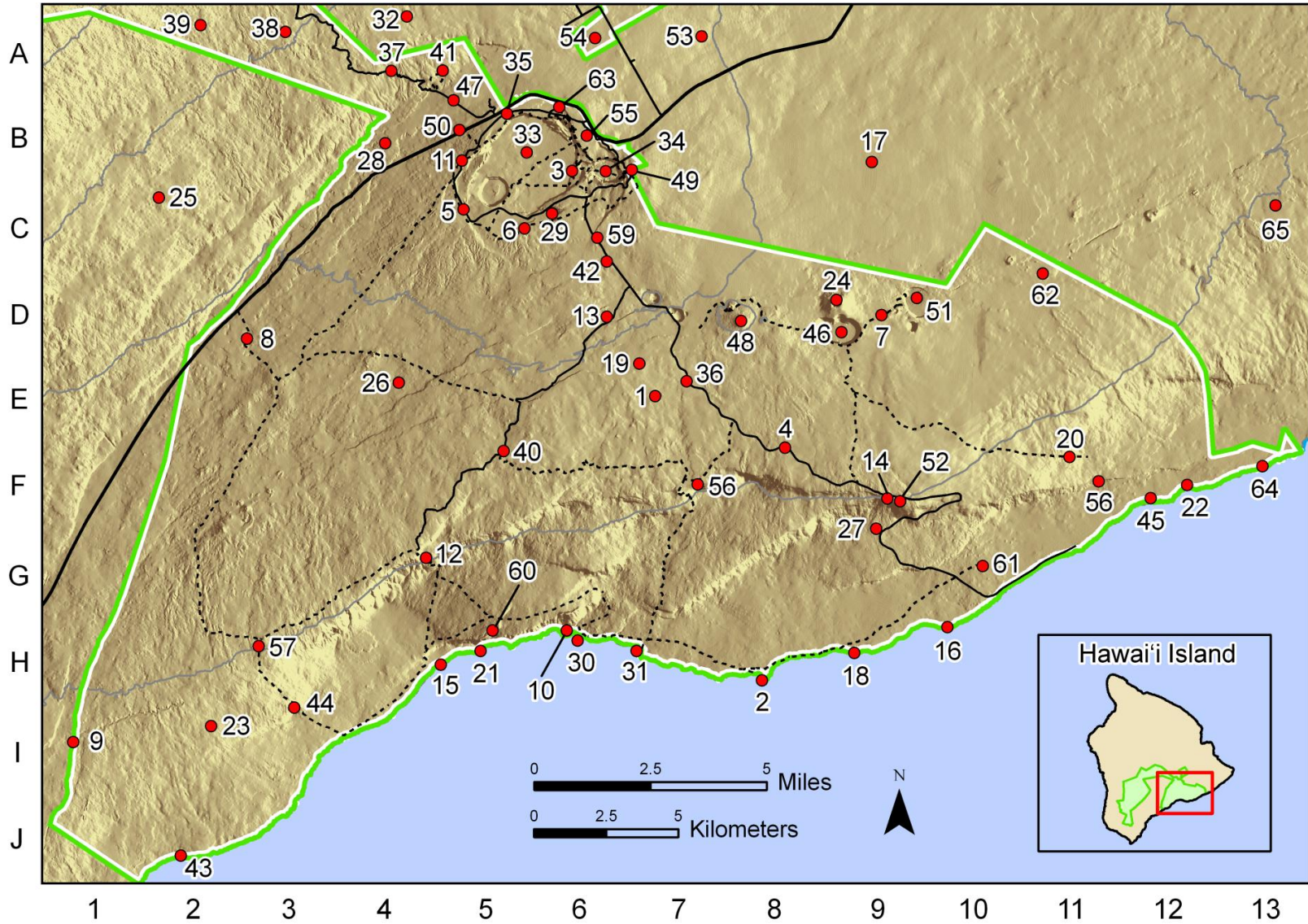


Figure 2. Place names used in the text. Numbers correspond to place names listed in Table 2.

Table 2. Place Names Used in the Text. (Numbers within the map identify place names listed below. Letters and numbers at map margins reference localities.)

Label	Place Names	Map Index	Label	Place Names	Map Index
1	`Āinahou; `Āinahou Ranch	E7	35	Kīlauea Military Camp (KMC)	B5
2	`Āpuā Point	H8	36	Kīpuka Kahali`i	E7
3	Byron's Ledge	B6	37	Kīpuka Kī	A4
4	Chain of Craters Road	F8	38	Kīpuka Kulalio; Mauna Loa SEA	A3
5	Crater Rim Drive	C5	39	Kīpuka Mauna`iu; Mauna Loa SEA	A2
6	Crater Rim Trail	C5	40	Kīpuka Nēnē	F5
7	East Rift; East Rift Special Ecological Area (SEA)	D9	41	Kīpuka Puauu	A5
8	Footprints	D3	42	Ko`oko`olau Crater	C6
9	Great Crack	I1	43	Kū`ē`ē	J2
10	Halapē	H6	44	Kukalau`ula	H3
11	Hawaiian Volcano Observatory (HVO), Uwekahuna	B5	45	Lae`Apuki	F12
12	Hilina Pali	G4	46	Makaopuhi Crater	D9
13	Hilina Pali Road	D6	47	Mauna Loa Road	B5
14	Hōlei Pali	F9	48	Mauna Ulu	D8
15	Ka`aha	H5	49	Nāhuku (Thurston Lava Tube)	B7
16	Ka`ena Point	H10	50	Nāmakani Paio	B5
17	Kahauale`a Natural Area Reserve (NAR)	B9	51	Nāpau Crater	D9
18	Kahue	H9	52	Nāulu Forest	F9
19	Kalanaokuaiki Pali	E7	53	`Ōla`a Forest Reserve	A7
20	Kalapana, Kalapana Trail	F11	54	`Ōla`a Small Tract; `Ōla`a SEA	A6
21	Kālu`e	H5	55	Old Volcano House; Park Headquarters	B6
22	Kamoamoā	F12	56	Paliuli	F11
23	Kamo`oali`i	I2	57	Pepeiau; Kīpuka Pepeiau	H3
24	Kāne Nui o Hamo	D9	58	Poliiokeawe Pali	F7
25	Kapāpala; Kapāpala Ranch	C2	59	Puhimau Crater	C6
26	Ka`ū Desert	E4	60	Pu`u Kaone	H5
27	Kealakomo	F9	61	Pu`u Loa	G10
28	Ke`āmoku Lava Flow	B4	62	Pu`u`Ō`ō	D11
29	Keanakāko`i Crater	C6	63	Sulphur Banks	B6
30	Keaoi Island	H6	64	Waha`ula	F13
31	Keauhou (Landing)	H7	65	Wao Kele o Puna	C13
32	Keauhou Ranch	A4			
33	Kīlauea Caldera; Kīlauea Volcano	B5			
34	Kīlauea Iki	B6			

Key to Federal and State Status Categories

E = Endangered. Officially listed by the U.S. Fish and Wildlife Service as a species in danger of extinction across all or a significant portion of its range (U.S. Fish and Wildlife Service 1988, 2009a). All species listed as endangered by the federal government are also considered endangered by the State of Hawai`i.

T = Threatened. Officially listed by the U.S. Fish and Wildlife Service as a species likely to become endangered in the future over all or part of its range (U.S. Fish and Wildlife Service 1988, 2009a). All species listed as threatened by the federal government are also considered threatened by the State of Hawai`i.

P = Proposed. Formally proposed as a threatened or endangered species by the U.S. Fish and Wildlife Service via publication in the Federal Register (U.S. Fish and Wildlife Service 2009a).

C = Candidate. A candidate for listing under the Endangered Species Act, not yet formally proposed (U.S. Fish and Wildlife Service 2009a).

SOC = Species of Concern. A rare species on a list maintained by the Honolulu Office of Ecological Services, U.S. Fish and Wildlife Service (2008), about which not enough is known to prepare a formal listing package. Many of these (plant) species were formerly Candidate Endangered Species. This list is subject to change yearly. Most plants on the federal list are also considered Species of Concern by the State of Hawai`i (2009); those species not included on the state list are noted as no status. A few species are considered Species of Concern by the State of Hawai`i but have been recently deleted from the federal list.

Ex = Extinct. Recognized by several publications as extinct (Hawaii Audubon Society 1997, Pyle 2002, AOU 2010).

NS = No Status. Recently deleted from the federal list of Species of Concern or not listed by the State of Hawai`i.

Acknowledgements and Photograph Credits

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Table 3. Endangered, Threatened, and Rare Animal Species of Hawai`i Volcanoes National Park

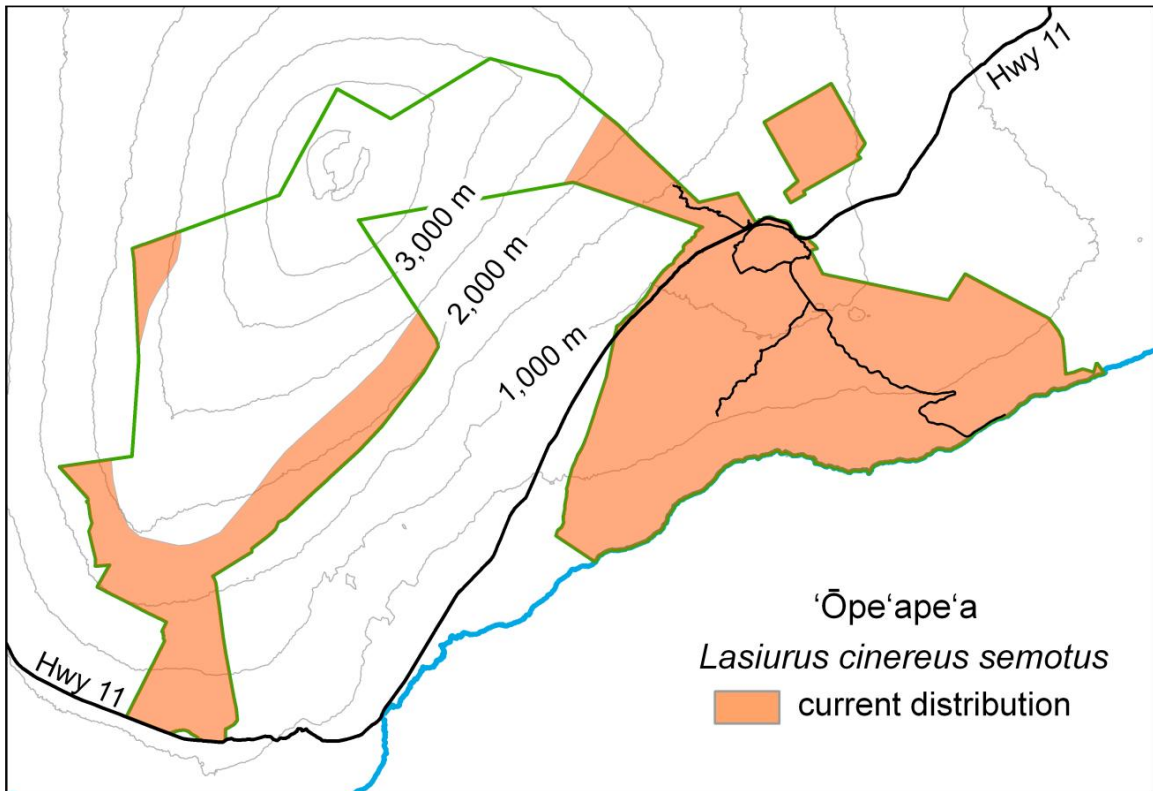
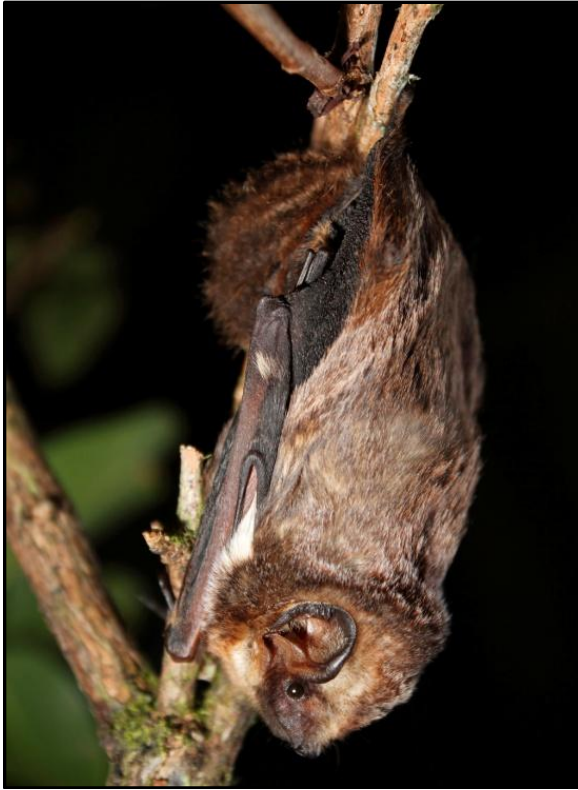
Common Name (Family)	Scientific Name	Status*
Mammals		
ʻŌpeʻapeʻa, Hawaiian hoary bat (Vespertilionidae)	<i>Lasiurus cinereus</i> subsp. <i>semotus</i>	E
ʻIlio holo i ka uaua, Hawaiian monk seal (Phocidae)	<i>Monachus schauinslandi</i>	E
Birds		
Nēnē, Hawaiian goose (Anatidae)	<i>Branta sandvicensis</i>	E
ʻUaʻu, Hawaiian petrel (Procellariidae)	<i>Pterodroma sandwichensis</i>	E
ʻAkeʻake, Band-rumped storm-petrel (Hydrobatidae)	<i>Oceanodroma castro</i>	C
ʻIo, Hawaiian hawk (Accipitridae)	<i>Buteo solitarius</i>	E
Peregrine falcon (Falconidae)	<i>Falco peregrinus tundrius</i>	SOC
Kioea, Bristle-thighed curlew (Scolopacidae)	<i>Numenius tahitiensis</i>	SOC
Pueo, Short-eared owl (Strigidae)	<i>Asio flammeus sandwichensis</i>	NS
ʻAlalā, Hawaiian crow (Corvidae)	<i>Corvus hawaiiensis</i>	E
ʻŌʻū (Fringillidae/Drepanidinae)	<i>Psittirostra psittacea</i>	E
ʻAkiapōlā`au (Fringillidae/Drepanidinae)	<i>Hemignathus munroi</i>	E
Hawai`i creeper (Fringillidae/Drepanidinae)	<i>Oreomystis mana</i>	E
Hawai`i `ākepa (Fringillidae/Drepanidinae)	<i>Loxops coccineus coccineus</i>	E
Reptiles		
Honu, Green turtle (Cheloniidae)	<i>Chelonia mydas</i>	T
Honu `ea, Hawksbill turtle (Cheloniidae)	<i>Eretmochelys imbricata</i>	E
Invertebrates		
Pāpala picture-wing fly (Drosophilidae)	<i>Drosophila digressa</i>	C
Hammerhead picture-wing fly (Drosophilidae)	<i>Drosophila heteroneura</i>	E
Mull's picture-wing fly (Drosophilidae)	<i>Drosophila mulli</i>	T
Enigmatic picture-wing fly (Drosophilidae)	<i>Drosophila ochrobasis</i>	E
Flying earwig damselfly (Coenagrionidae)	<i>Megalagrion nesiotetes</i>	P
Orange-black damselfly (Coenagrionidae)	<i>Megalagrion xanthomelas</i>	C
Scavenging anchialine pool shrimp (Alpheidae)	<i>Metabetaeus lohena</i>	C

*E=Endangered, T=Threatened, P=Proposed Endangered, C=Candidate Endangered, SOC=Species of Concern, NS=No status, rare in HAVO. Status is both federal and State of Hawai`i, except for NS which is not officially recognized by the state or USFWS.

Table 4. Extinct Animal Species of Hawai`i Volcanoes National Park

Common Name	Scientific Name	Last Seen*
Moho, Hawaiian rail (Rallidae)	<i>Porzana sandwichensis</i>	1860s?
Hawai`i `ō`ō (Mohoidae)	<i>Moho nobilis</i>	1902
Greater koa-finch (Fringillidae/Drepanidinae)	<i>Rhodacanthis palmeri</i>	1937
Lesser `akialoa (Fringillidae/Drepanidinae)	<i>Hemignathus obscurus</i>	1940
Hawai`i mamo (Fringillidae/Drepanidinae)	<i>Drepanis pacifica</i>	1898

*Dates from Banko and Banko 2009, except the Hawaiian rail (Olson 1999).



Ōpe'ape'a, Hawaiian hoary bat, *Lasiurus cinereus* subsp. *semotus*
Photo: Jack Jeffrey

COMMON NAME: **`Ōpe`ape`a, Hawaiian hoary bat**

SCIENTIFIC NAME: *Lasiurus cinereus* subsp. *semotus*

FAMILY: Vespertilionidae (Common Bats)

SYNONYMS: *Lasiurus semotus*

FEDERAL AND STATE STATUS: Endangered, listed in 1970

DESCRIPTION: The Hawaiian hoary bat is small, ranging from 14 to 22 grams in mass. Females are larger than males. Fur color is variable but is typically a mixture of reddish brown and gray with grizzled silvery white hairs. Hawaiian hoary bats are smaller and many are more reddish than mainland hoary bats (Tomich 1986).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: The species is native to temperate regions of North and South America and island groups such as the Bermudas and Galápagos. The endemic subspecies is known from the islands of Kaua`i, O`ahu, Maui, and Hawai`i but may occur sporadically on other Hawaiian Islands and offshore islets (Tomich 1986). The size of the bat populations on these islands is unknown.

HAVO DISTRIBUTION: Hawaiian hoary bats can be expected almost anywhere in the park, although they are only rarely found above timberline. Bats are occasionally seen in the forest near Nahuku (Thurston Lava Tube) but are more likely to be observed at dusk along the Mauna Loa Road. A recent inventory detected Hawaiian hoary bats in the park at several sites along the Mauna Loa Road and western **Highway 11 and on the edge of Kilauea Caldera (Fraser *et al.* 2007).**

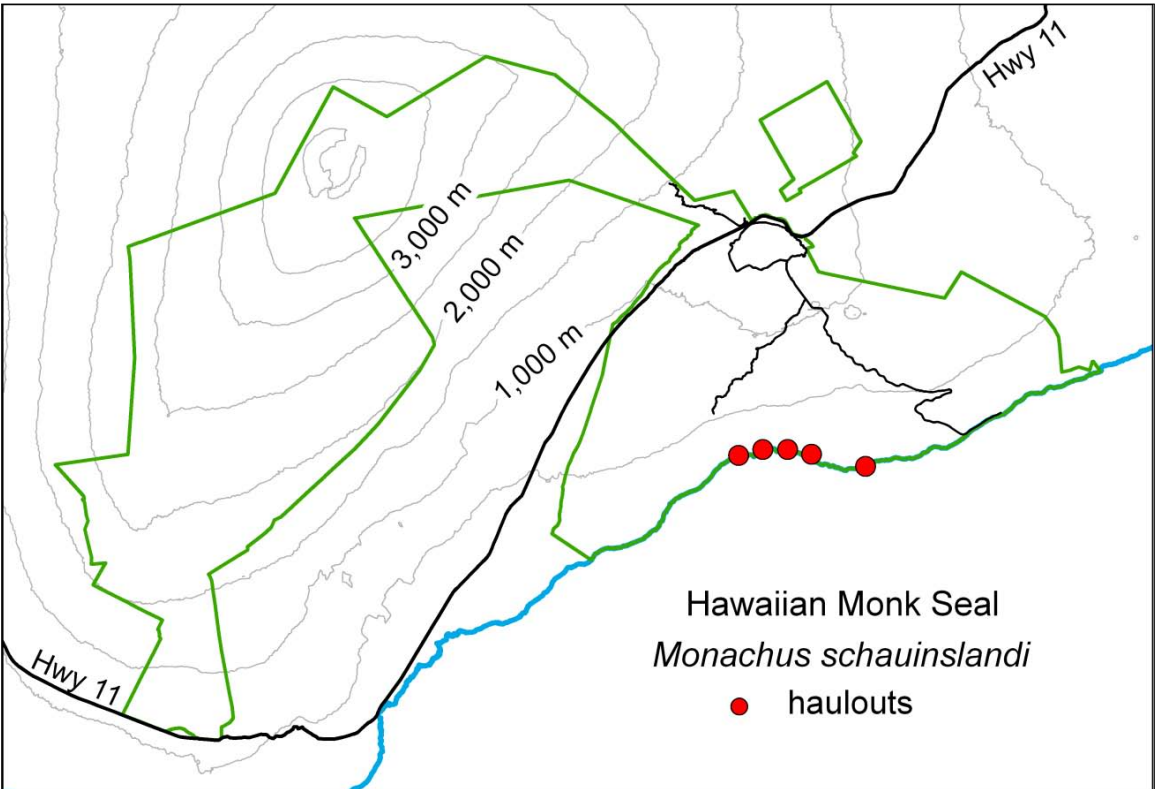
HABITAT: **The hoary bat or `ōpe`ape`a appears to be most numerous in native dry to mesic forests,** particularly those found in South Kona District. However, these bats have been noted to use many types of habitats, and they may even be seen foraging over water at the coast. In the recent bat survey mentioned above, Hawaiian hoary bats appeared to be associated with native forest edges.

HABITS: This bat flies continuously while foraging for insect prey, typically moths and beetles. Roosts are in native or nonnative trees, particularly those that are tall. **The `ōpe`ape`a usually leaves its roost** soon after sunset (Jacobs 1993).

SIMILAR SPECIES: No other bats are native to Hawai`i. Do not confuse with the large black witch moth that is often seen flying at dusk.

THREATS: Loss of forest habitat across hoary bat range and within the park due to volcanic activity and fire is the main threat. Bats perish when snared on barbwire fences. Pesticides are a potential threat (U.S. Fish and Wildlife Service 1998a).

MANAGEMENT/RESTORATION STRATEGIES: Protection of native vegetation within the park is a primary goal of HAVO. More research may be needed to define Hawaiian hoary bat roosting and foraging habitat in the park (Fraser 2005). Barbwire is not used on park fences except at ground level to deter feral pigs. Pesticides to control insects are not broadcast within HAVO.



ʻIlio holo i ka uua, Hawaiian monk seal, *Monachus schauinslandi*
Photo: Will Seitz, NPS, HAVO, Hawksbill Turtle Project

COMMON NAME: **`Ilio holo i ka uua, Hawaiian monk seal**

SCIENTIFIC NAME: *Monachus schauinslandi*

FAMILY: Phocidae (Hair Seals)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered, listed in 1976

DESCRIPTION: Adults have silver-grey fur that is often darker in males. Newborn pups are jet-black with short wooly hair. Females grow slightly larger than males and display more variation in weight. Adult females reach 2.3 m long while adult males measure approximately 2.1 m at maturity. Newborn pups are about one meter in length. The average weight for adult females is 205 kg compared with 170 kg for males. Newborn pups weigh on average 16 kg (National Oceanic and Atmospheric Administration [NOAA] 2010a).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: There are fewer than 1,200 Hawaiian monk seals, and these are known primarily in the Northwestern Hawaiian Islands (NOAA 2010a). On the main islands, monk seal sightings have recently increased but are still rare. Overall, the monk seal has shown alarming population declines in recent years due to a variety of causes.

HAVO DISTRIBUTION: At the time of writing, there were just a few animals that visited HAVO. Monk seals have been observed hauled-out along the **park coast at `Āpua, Ka`aha, and several beaches near Halapē**. Park biologists consider all park beaches to be potential sites for monk seals to bask, rest, or give birth.

HABITAT: The Hawaiian monk seal is mainly found on the sandy beaches and in the surrounding waters of the Northwestern Hawaiian Archipelago. **Ten islands and reefs there have been designated as "critical habitat" (NOAA 2010a). Monk seals are occasionally observed on beaches and rocky coasts** of the main Hawaiian Islands basking or with pups.

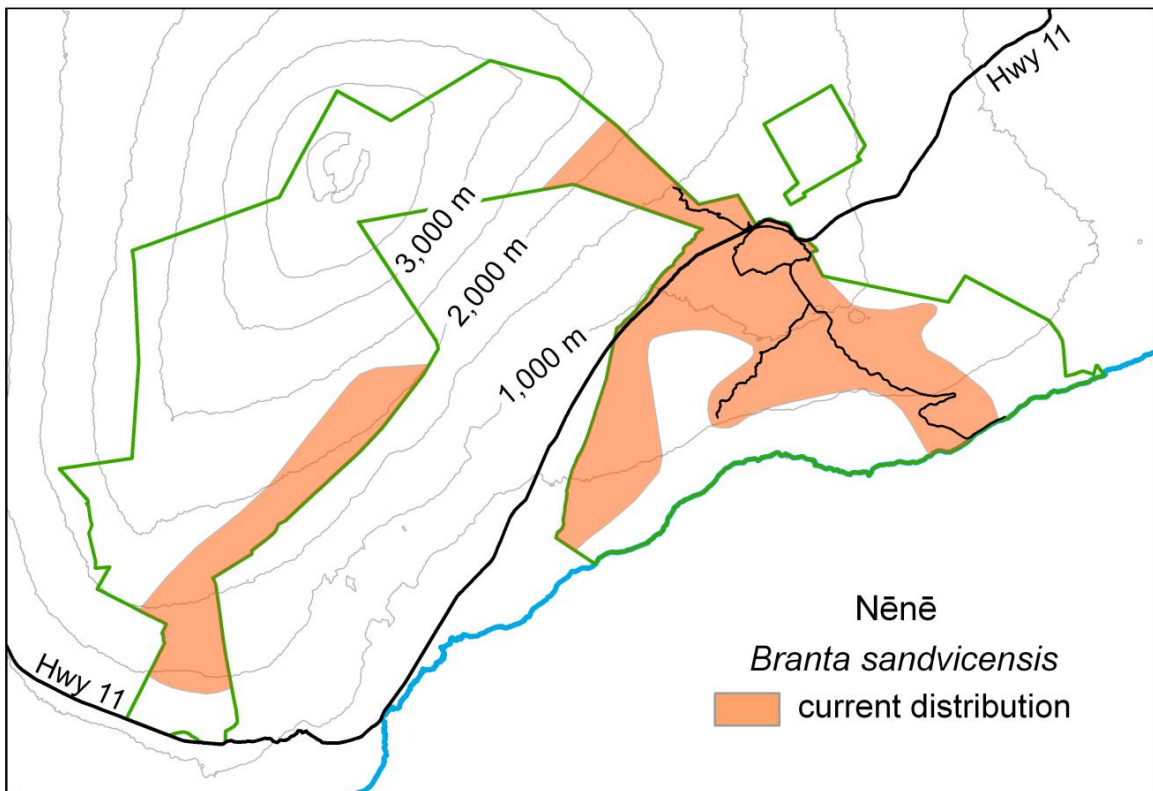
HABITS: Hawaiian monk seals feed on fish, cephalopods (octopi and squid), and crustaceans. These prey they catch near shore and usually at night, although juveniles tend to find their prey under rocks on sandy or rocky bottoms during the day. The mother seal gives birth on a beach or rocky shore, often in spring (NOAA 2010a). Here she leaves her pup for long periods when she enters the water to feed. The mother seal will defend her pup from a perceived threat and will bite. Human observers should not approach or otherwise disturb a resting seal.

SIMILAR SPECIES: No other seals are known in Hawaiian waters, although there was a rare sighting of an elephant seal (*Mirounga angustirostris*).

THREATS: Food limitation, entanglement in marine debris, human disturbance, and disease outbreaks appear to be the **main causes of the Hawaiian monk seal's diminishing numbers (National Marine Fisheries Service 2007)**. Their primary predator is the tiger shark (Tomich 1986). Female seals also die from "mobbing," when numerous adult males attempt to mate with a single female.

MANAGEMENT/RESTORATION STRATEGIES: Management of monk seal populations in Hawai`i falls under the National Marine Fisheries Service and National Oceanographic and Atmospheric Administration. The primary habitat and range of monk seals is now protected within the newly-formed **Papahānaumokuākea Marine National Monument**, which encompasses the Northwestern Hawaiian Islands. The main restoration strategy for the seal population in the park is to protect it from human disturbance.

REMARKS: The Hawaiian name means **"dog that runs in rough water" (Pukui and Elbert 1971)**. Monk seals that haul-out to rest or sleep should not be disturbed. If you see a seal along the shore, do not approach closer than 30 m and move away if the seal takes notice of you.



Nēnē, Hawaiian goose, *Branta sandvicensis*
Photo: Kathleen Misajon, NPS, HAVO

COMMON NAME: **Nēnē, Hawaiian goose**
SCIENTIFIC NAME: *Branta sandvicensis*
FAMILY: Anatidae (Ducks, Geese, and Swans)
SYNONYMS: *Nesochen sandvicensis*
FEDERAL AND STATE STATUS: Endangered, listed in 1967

DESCRIPTION: The only wild goose resident in the islands. Length 64 cm. Distinguished by the black face and stripe running down the back of the neck and by its terrestrial lifestyle. The beige color and furrows on the sides of the neck are distinctive. With sleek build and rather long legs, the **nēnē** is a swift and nimble runner. Partially webbed feet are likely a compromise between two functions—assisting the walking **nēnē** and retaining paddling ability in the water. Downy goslings begin to grow feathering at six weeks that transforms them into slender, dusky versions of the parents by 12 weeks (Banko *et al.* 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Formerly distributed on all main islands. Following Polynesian settlement, hunting is believed to have eliminated **the nēnē** from all islands except Hawai`i and perhaps Maui. In recent years, **nēnē** have been successfully reintroduced to Kaua`i, Moloka`i, and Maui (U.S. Fish and Wildlife Service 2004).

HAVO DISTRIBUTION: Sporadically distributed in the park from the coast to 2,440 m (8,000 ft) elevation. **Nēnē** use different areas of the park depending on the season. They are often met with at various stops along the Crater Rim Drive and Chain of Craters Road. Sustained management has maintained numbers at about 200 birds in the original section of the park. **The number of nēnē at Kahuku is unknown but is currently being studied.**

HABITAT: **Nēnē** inhabit wetlands, grasslands, and shrubland from sea level to above timberline. The lowlands are believed **to have been the nēnē's** original stronghold. Since the arrival of people and predatory mammals, **nēnē** have been largely confined to higher elevations. Upland habitat offers little food and poor climate for goslings. **In HAVO, nēnē** turn up in almost any open shrubland or grass.

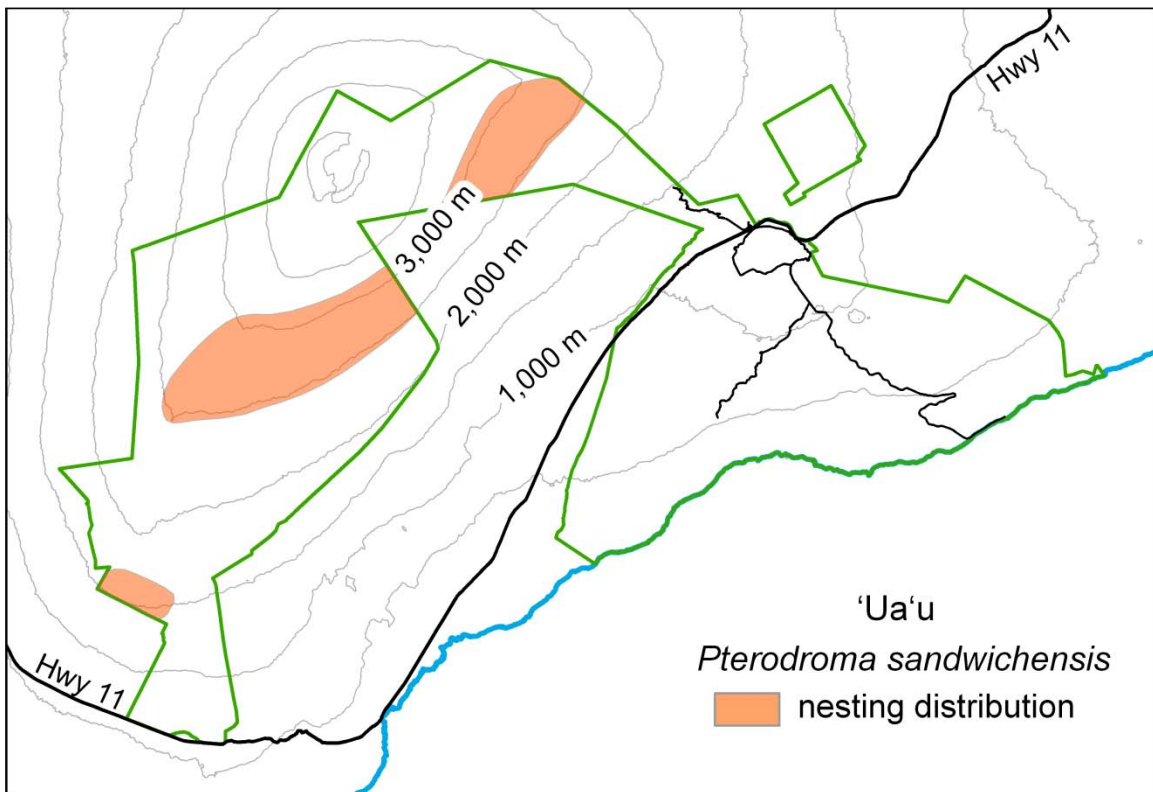
HABITS: Grazes on grasses and browses selectively on foliage and fruit (Black *et al.* 1994; Sherry 2000). Grass leaves and seeds are important components of the diet, and berries of native shrubs such as **pūkiawe, `ōhelo, and kūkae nēnē are also relished.** Attracted to roadsides, lawns, and gardens by foraging opportunities, **nēnē** readily become pan-handlers when offered food by humans. **Nēnē** hide nests in dense cover, where the female incubates up to five eggs. The male stands guard and later helps attend the brood when they leave the nest after hatching. While the goslings grow, the parents molt their feathers and become temporarily flightless. Their voice is **a mournful "ne-ne," recalling their** Hawaiian name (Banko *et al.* 1999).

SIMILAR SPECIES: Canada geese and other migratory geese, all with plumage patterns different from **nēnē**, rarely stray to the islands and overwinter in wetlands. Most subspecies of Canada geese are larger **than nēnē and have a pronounced white "chin strap" from ear to ear.**

THREATS: Mainly predation of eggs, goslings, and adults by mongooses, cats, and dogs. Rats also take eggs, and surprisingly, feral pigs may eat eggs and kill goslings. Some birds, especially panhandlers, are killed by automobiles. Droughts and storms may also lead to losses.

MANAGEMENT/RESTORATION STRATEGIES: Goals are to improve reproduction by providing habitat with abundant high-quality food, to reduce predation by removing predators, and to reduce road mortality by discouraging panhandling. Because of poor recruitment, populations of wild **nēnē are supplemented by** releases of captive-reared birds (Rave *et al.* 2005).

REMARKS: Likely that **HAVO has always been marginal nēnē habitat, particularly for breeding birds,** which require high-quality forage. HAVO does **offer visitors the opportunity to see Hawai`i's state bird.**



'Ua'u, Hawaiian petrel, *Pterodroma sandwichensis*
Photo: Winston Banko, NPS, HAVO files

COMMON NAME: **`Ua`u, Hawaiian petrel**

SCIENTIFIC NAME: *Pterodroma sandwichensis*

FAMILY: Procellariidae (Shearwaters and Petrels)

SYNONYMS: Dark-rumped Petrel; *Pterodroma phaeopygia sandwichensis*

FEDERAL AND STATE STATUS: Endangered, listed in 1967

DESCRIPTION: A slate-black, tube-nosed seabird with white face and underparts. Length 43 cm.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Formerly reported from all main islands except Ni`ihau. Now its distribution is restricted to Kaua`i, Lāna`i, Maui, Hawai`i, and possibly Moloka`i. Largest colonies may be on Kaua`i.

HAVO DISTRIBUTION: Hawaiian petrels nest in colonies primarily above 2,440 m (8,000 ft) elevation on Mauna Loa at several sites within the park. At Kahuku Unit on the western slope of Mauna Loa, nesting may extend down to 1,680 m (5,500 ft) elevation. Park scientists have mapped and studied many of these sites, but the vast and remote upper slopes of Mauna Loa are difficult to survey. Probably no more than a few hundred birds are nesting in HAVO. Because the birds are active around the colonies only at night, and because they nest underground, the sites are not obvious to the passerby. Fledglings, identified by traces of natal down, occasionally are found in November on roads or near lighted buildings. These individuals were on their nocturnal fledging journey to the sea and collided with some obstruction or became disoriented by artificial lighting. Once at sea, Hawaiian petrels are rarely sighted from shore.

HABITAT: Hawaiian petrels once nested in a broad range of habitats throughout the islands. They still site their nest burrows locally in mountain forests or large tangles of fern (Harrison 1990). However, the birds nesting in HAVO each year seek out the same barren pāhoehoe lava flows, usually above timberline. Here they select passages in the rock in which to lay their single egg and rear their chick. At sea, the birds prefer the open ocean and avoid the coast.

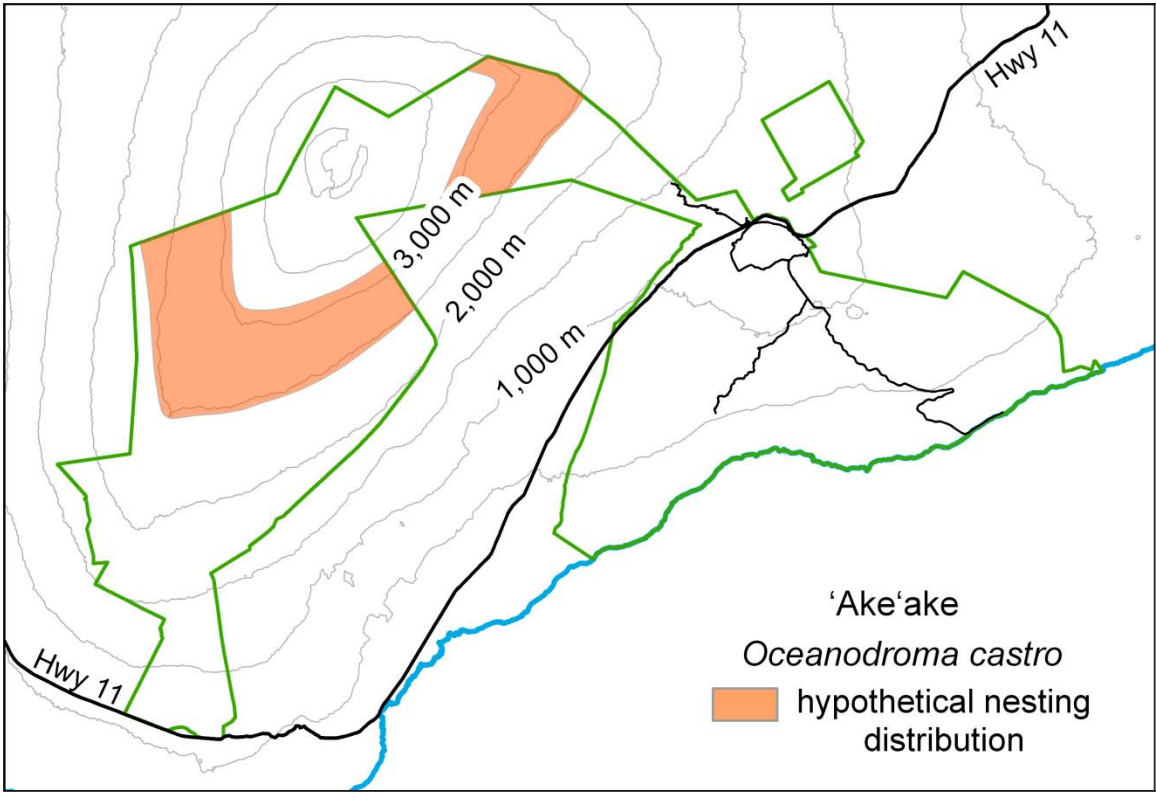
HABITS: Hawaiian petrels feed on squid, fish, and crustaceans which they capture by diving. Members of a pair mate for life and share nesting duties. They lay only one white egg in a season. Hawaiian petrels do not nest until their 1st or 2nd year, but breed for many years hence. The birds make a variety of sounds, but two primary calls are distinguished. The first call sounds much like the **bird's** Hawaiian name and is loud and penetrating; the second call is a raspy, nasal sound (Simons and Hodges 1998).

SIMILAR SPECIES: The most similar seabird to be seen from shore is the Wedge-tailed shearwater (*Puffinus pacificus*), which has a proportionately longer bill, has dark brown rather than slate black plumage, and lacks the white forehead. **Newell's shearwater or `a`o** (*Puffinus auricularis newelli*) is dark black above and white below, but it is rare on Hawai`i Island.

THREATS: Depredation from feral cats at nesting sites is the primary threat. Other threats are mongooses, rats, barn owls, and collisions with structures (Simons and Hodges 1998).

MANAGEMENT/RESTORATION STRATEGIES: Reducing or eliminating predators at nest sites increases adult survival and reproduction, an important objective for a species that is slow to breed (U.S. Fish and Wildlife Service and Telfer 1983). Logistical difficulties limit the amount of management the park can accomplish because colonies are in remote areas. Fledglings or adults stranded in transit to or from the sea are picked up and rehabilitated, if necessary, before being released along the coast. The type and placement of street and security lighting within HAVO is limited, and therefore reduces disorientation of night-flying seabirds.

REMARKS: Early Hawaiians harvested petrel chicks for food. Some of the nesting sites of petrels appear to have been modified to facilitate annual removal of young birds. The Hawaiian petrel was formerly considered a subspecies of the Galápagos petrel (*Pterodroma phaeopygia*).



`Ake`ake, Band-rumped storm-petrel, *Oceanodroma castro*
No photo

COMMON NAME: **`Ake`ake, Band-rumped storm-petrel**

SCIENTIFIC NAME: *Oceanodroma castro*

FAMILY: Hydrobatidae (Storm-petrels)

SYNONYMS: Madeiran storm-petrel, **Harcourt's storm-petrel**

FEDERAL AND STATE STATUS: Candidate Endangered Species (federal), Endangered (state of Hawai`i)

DESCRIPTION: A tern-sized (23 cm), blackish brown, tube-nosed seabird with striking white band on the rump. Note the long legs and webbed feet.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Poorly known, but the presence of downed birds and locations of what are thought to be calls of this species indicate breeding on the islands of Kaua`i, Maui, and Hawai`i. The species ranges in the Atlantic and Pacific Oceans (Slotterback 2002).

HAVO DISTRIBUTION: The presence of this species in the park is only indicated by night-time calls and very rarely by fledglings found along roadsides or near lighted buildings. These young birds recovered in the park still retained traces of natal down. Their journey in the dark from the nesting ground to a new life at sea had been interrupted by collision with an obstruction in their path, such as a powerline, or by disorientation in the presence of artificial lights. Band-rumped storm-petrels are believed to nest somewhere above 2,440 m (8,000 ft) elevation on Mauna Loa, perhaps within the Kahuku Unit and the Mauna Loa Strip. Adults forage far out at sea and cannot be seen from shore.

HABITAT: Nesting sites unknown, but possibly the walls of craters or holes and fissures in lava. The birds come ashore only to nest; they spend the rest of their lives at sea.

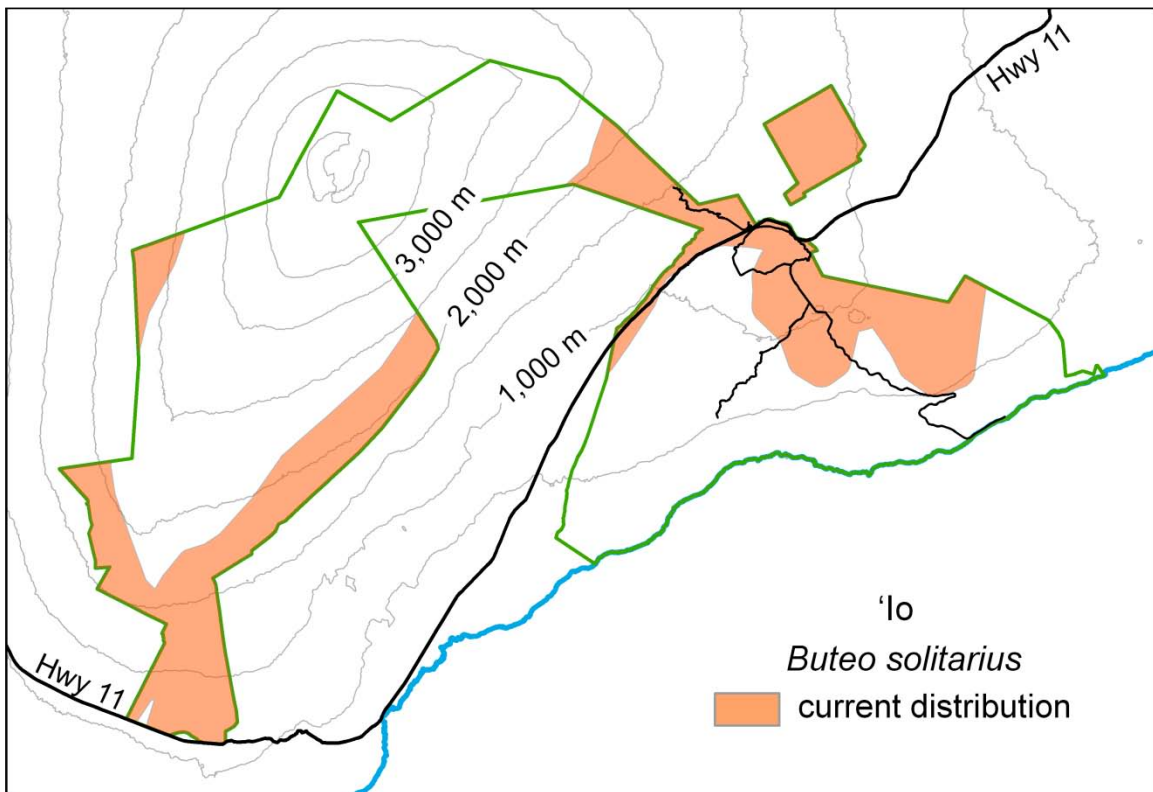
HABITS: Band-rumped storm-petrels feed on plankton, small fish, and squid plucked from the ocean surface. Elsewhere in the world, they nest colonially in holes on flat areas of small islands and on cliffs of larger islands. Members of a pair mate for life and share all nesting duties, including incubation of the single, large, white egg. Two calls are recognized: the flight call, which is an irregularly repeated phrase **"kair chuk-a-chuk chuck, kair chuk-a-chuck chuck chuck,"** and a **guttural burrow call** (Slotterback 2002, p. 8).

SIMILAR SPECIES: Much smaller than the Hawaiian petrel and differently colored. Black noddies (*Anous minutus*) along the coast do not have either the tubenose or white rump.

THREATS: As for Hawaiian petrel; depredation by feral cats at nesting sites is presumed to be the most serious threat. Collisions with structures also occur (Slotterback 2002).

MANAGEMENT/RESTORATION STRATEGIES: Park biologists recently surveyed the slopes of Mauna Loa above timberline to find the location of breeding colonies and nest sites of Hawaiian petrels and band-rumped storm-petrels. The storm-petrels proved to be elusive, and the whereabouts of their nesting sites remain a mystery (D. Hu, pers. comm.). While the park would like to protect storm-petrels by reducing the number of predators at nest sites or fencing the colonies to exclude predators, such actions are not feasible until these sites can be identified.

REMARKS: This is one of the least known bird species in HAVO. The presence of large numbers of `ake`ake bones in middens on Hawai`i and O`ahu indicate that the birds were consumed by Hawaiians and extirpated from some areas (Harrison 1990).



'Ilo, Hawaiian hawk, *Buteo solitarius*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **`Io, Hawaiian hawk**

SCIENTIFIC NAME: *Buteo solitarius*

FAMILY: Accipitridae (Hawks, Kites, Eagles, and Allies)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered, listed in 1967

DESCRIPTION: This is the only hawk native to Hawai`i. For a *Buteo* hawk, it is quite heavy-bodied and small, and the sexes differ greatly in size: the small male is 41 cm, the female is 46 cm long. The `io comes in two color phases, light or dark. Light phase adults are dark brown above and white below, whereas their dark phase counterparts are uniformly dark brown. For their first couple of years, light phase birds have a yellowish white head, and dark phase birds, while already mainly brown, have some white feathers mixed in. The `io is usually seen soaring, carried aloft on short wings held in a shallow "V."

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i Island from sea level to 2,600 m (8,530 ft) elevation (Scott *et al.* 1986). Fossils have been found on Kaua`i and Moloka`i (Olson and James 1997), suggesting that the `io likely inhabited other islands. Surveys for `io in 2007 estimated a population of 3,100 birds throughout the island (Gorresen *et al.* 2008).

HAVO DISTRIBUTION: Few `io inhabit HAVO, mostly for lack of forest and prey over the large, barren expanses of recent volcanic terrain. `Io can be expected in all forested areas within HAVO, where they are regularly seen at sites such as Kīpuka Puaulu, Kīpuka Kī, Mauna Loa Road, Kīlauea Caldera edge, and **Kīlauea Iki Crater rim**. During a recent survey of Kahuku Unit, `io were sighted in the central pasture, at **the forest edge above Ka`ū Forest Reserve, and in woodland of the far northwestern section of the unit** (Tweed *et al.* 2007).

HABITAT: This adaptable native raptor favors forests and agricultural lands with at least some trees (Klavitter 2009).

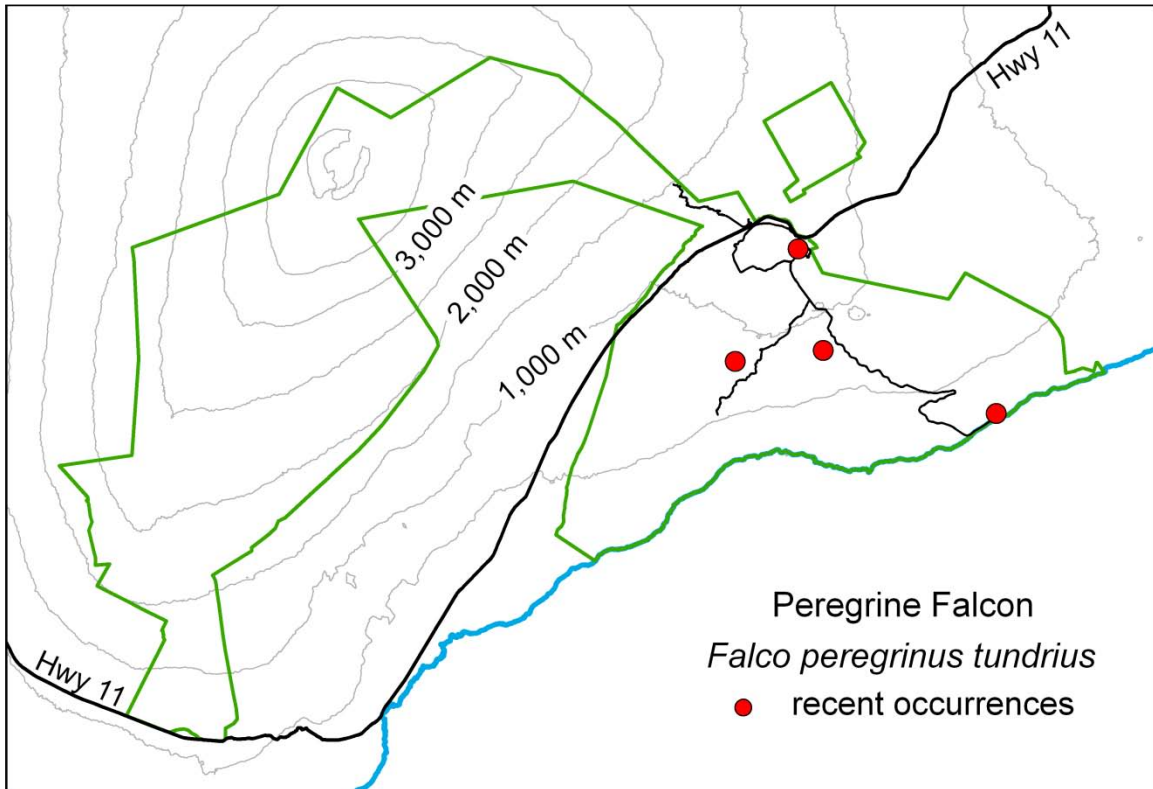
HABITS: An aggressive hunter of rodents and small birds, `io take prey as large as young pheasants. The nest is a bulky structure of sticks, usually built in the branches of an `ōhi`a lehua tree. Adults nest together for many years, often using the same nest over again. They typically raise one young. **The name "`io" is a rendering of the hawk's scream.**

SIMILAR SPECIES: None resident. Rarely, migratory hawks and falcons reach the islands (see the peregrine falcon), but with one extremely rare exception, the rough-legged hawk (*Buteo lagopus*), none of the migrants look much like an `io.

THREATS: Forest clearing and shooting (U.S. Fish and Wildlife Service 1984).

MANAGEMENT/RESTORATION STRATEGIES: Protecting habitat and encouraging the public to appreciate this wonderful bird.

REMARKS: `Io numbers remain stable without any special management, and their prospects for long-term survival are good.



Peregrine falcon, *Falco peregrinus* subsp. *tundrius*
Photo: Eric VanderWerf, Pacific Rim Conservation

COMMON NAME: **Peregrine falcon**
SCIENTIFIC NAME: *Falco peregrinus*
FAMILY: Falconidae (Caracaras and Falcons)
SYNONYMS: None
FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Somewhat larger than an ʻio and differently shaped. Males are 41 cm in length, and females are 51 cm. Long, narrow wings and fast, level flight characterize the peregrine. Note the black **cap and "sideburns," slate**-gray back, and white underparts with some black barring. Birds fledged the previous summer are similar to the adults but are dark brown above and are streaked rather than barred below (White *et al.* 2002).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Every fall, a few peregrine falcons from the arctic find their way to the Hawaiian Islands. Sometimes a bird will settle on one island for the winter, but just as likely it will be sighted on two or more islands. The falcons leave before summer, returning to the North American and Asian arctic. No other race from lower latitudes of either continent has been recorded from Hawaiʻi.

HAVO DISTRIBUTION: Infrequently sighted from November to April.

HABITAT: Anywhere, but more often concentrates activity along cliffs and forest edge where birds are most easily ambushed and chased down.

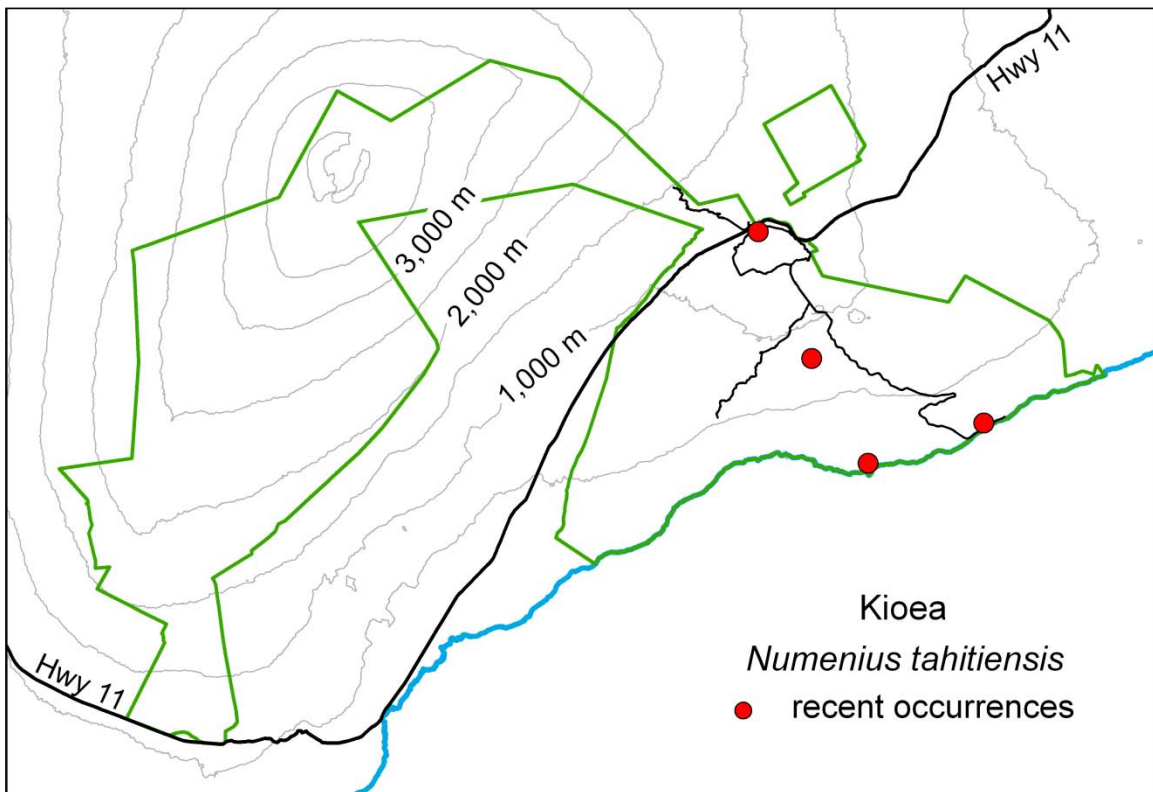
HABITS: Peregrine falcons typically pursue their avian prey with swift, powerful flight and steep-angled glides called stoops, during which the bird attains velocities of 25–100 m/second before striking its victim from the air (White *et al.* 2002). Usual targets are birds smaller than the peregrine. Prey items in Hawaiʻi are often shorebirds, such as the Pacific goldenplover. The calls of the peregrine are varied, but these birds are usually silent in Hawaiʻi.

SIMILAR SPECIES: Other falcons very rarely visit the islands. The ʻio has rounded wings and more typically soars rather than making long, sustained flights.

THREATS: Formerly brought nearly to extinction by secondary poisoning from insecticides, mainly DDT and its metabolized derivatives. The falcons pick up these chemicals in minute amounts when they feed on contaminated prey. The chemicals are stored and later interfere with the production of eggshells, which become thin and easily damaged.

MANAGEMENT/RESTORATION STRATEGIES: None in Hawaiʻi, other than protection of birds from shooting. Peregrine falcon populations have largely recovered in North America since the use of specific pesticides has been restricted (White *et al.* 2002).

REMARKS: Sightings of the peregrine falcon are very rare in HAVO, and the bird may appear in unexpected localities.



Kioea, Bristle-thighed curlew, *Numenius tahitiensis*
Photo: © Jack Jeffrey

COMMON NAME: **Kioea, Bristle-thighed curlew**
SCIENTIFIC NAME: *Numenius tahitiensis*
FAMILY: Scolopacidae (Sandpipers, Phalaropes, and Allies)
SYNONYMS: None
FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: A pigeon-sized shorebird with very long, down-curved bill. Length 43 cm.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: The migratory kioea breeds in Alaska and winters in the Pacific islands. It is rare in the main Hawaiian Islands and common in the Northwestern Hawaiian Islands. The kioea is also found in Micronesia, southeast and central Polynesia, and Fiji (Pratt *et al.* 1987).

HAVO DISTRIBUTION: Regularly sighted along the **park's coast during the autumn** (e.g., `Āpua Point and shoreline east of the Chain of Craters Road), more rarely on lawns at higher elevations (Kīlauea Military Camp **and** `Āinahou). The curlew was not detected in a recent survey of lowland birds in HAVO (Turner *et al.* 2006), nor was it noted in a recent shorebird survey of the park (Kozar *et al.* 2007).

HABITAT: On migration, curlews turn up along the coast on sandy beaches and marshy wetlands or expanses of short grass.

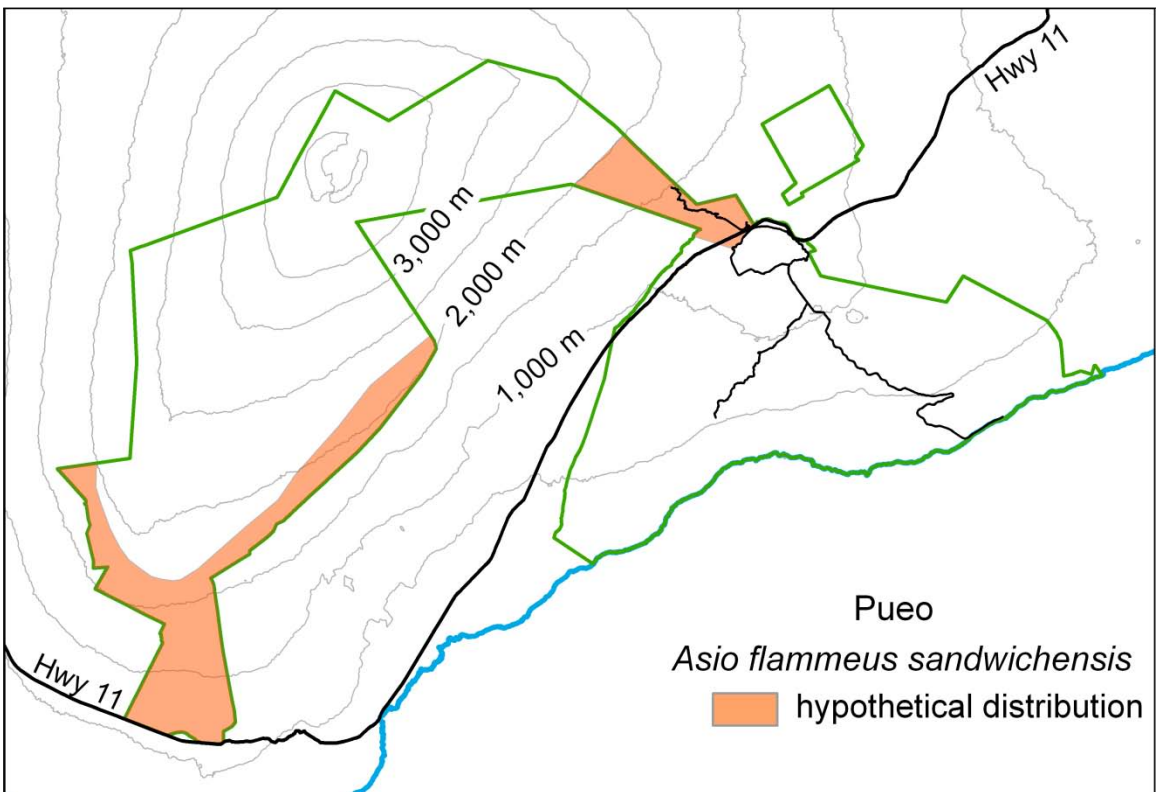
HABITS: Feeds mainly on invertebrates. **The curlew's voice is a quick "curlew" or "weoo-weet"** (Pratt *et al.* 1987, p. 149).

SIMILAR SPECIES: All other shorebirds in Hawai`i are much smaller and have shorter, straighter bills. A related species, the whimbrel (*Numenius phaeopus*), very rarely turns up in the Hawaiian Islands and can be identified by careful comparison using a field guide. The whimbrel lacks the buff-colored neck and orange-brown rump and tail of the bristle-thighed curlew (Pratt *et al.* 1987).

THREATS: The bristle-thighed curlew has a relatively small breeding range in western Alaska. Overwintering birds fall prey to cats and other carnivores when they lose most of their flight feathers during molt (an unusual molting pattern).

MANAGEMENT/RESTORATION STRATEGIES: There is not enough known about the bristle-thighed curlew habits and distribution in HAVO to allow managers to devise specific management strategies for the bird during its visits to the park. Control of mammalian predators would minimize curlew losses when the birds are in molt. The James Campbell National Wildlife Refuge on O`ahu and the **Papahānaumokuākea Marine National Monument of the Northwest Hawaiian Islands** protect the main overwintering grounds in the Hawaiian Islands. Protection of wetlands in Hawai`i has also benefitted this species.

REMARKS: This is one of the great long-distance migrants. Curlews fly nonstop for many thousands of miles from Alaska to the South Pacific islands. The kioea (*Chaetoptiila angustipluma*) is another bird with **the same Hawaiian name. It is an extinct song bird in the `ō`ō family (Mohoidae) once found on Hawai`i Island** (Rothschild 1893–1900).



Pueo, Short-eared owl, *Asio flammeus* subsp. *sandwichensis*

Photo: © Jack Jeffrey

COMMON NAME: **Pueo, Short-eared owl**

SCIENTIFIC NAME: *Asio flammeus* subsp. *sandwichensis*

FAMILY: Strigidae (Typical Owls)

SYNONYMS: *Asio accipitrinus sandvicensis*

FEDERAL AND STATE STATUS: No status (federal), Endangered on O`ahu (state of Hawai`i)

DESCRIPTION: This endemic subspecies of the widespread short-eared owl is a medium-sized owl, about 38 cm long. Its plumage is brown and buffy white with characteristic streaks of darker brown on the breast. The eyes are yellow. It is possible that the Hawaiian birds are indistinguishable from the migratory ones from North America and Asia.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Found on all the main Hawaiian Islands, but scarce on **O`ahu, Lāna`i**, and Moloka`i. On Hawai`i Island, this bird is most often seen in subalpine woodlands and pastures of Mauna Kea. Population estimates are not available for this species.

HAVO DISTRIBUTION: Probably no longer resident in the park, although visiting birds may be expected. Rarely seen along the Mauna Loa Road. It was not found at Kahuku Unit during a recent bird survey (Tweed *et al.* 2007), but the former ranch likely has suitable habitat for this owl. It was also not found recently in the park lowlands (Turner *et al.* 2006).

HABITAT: Dry woodlands, shrublands, and grasslands.

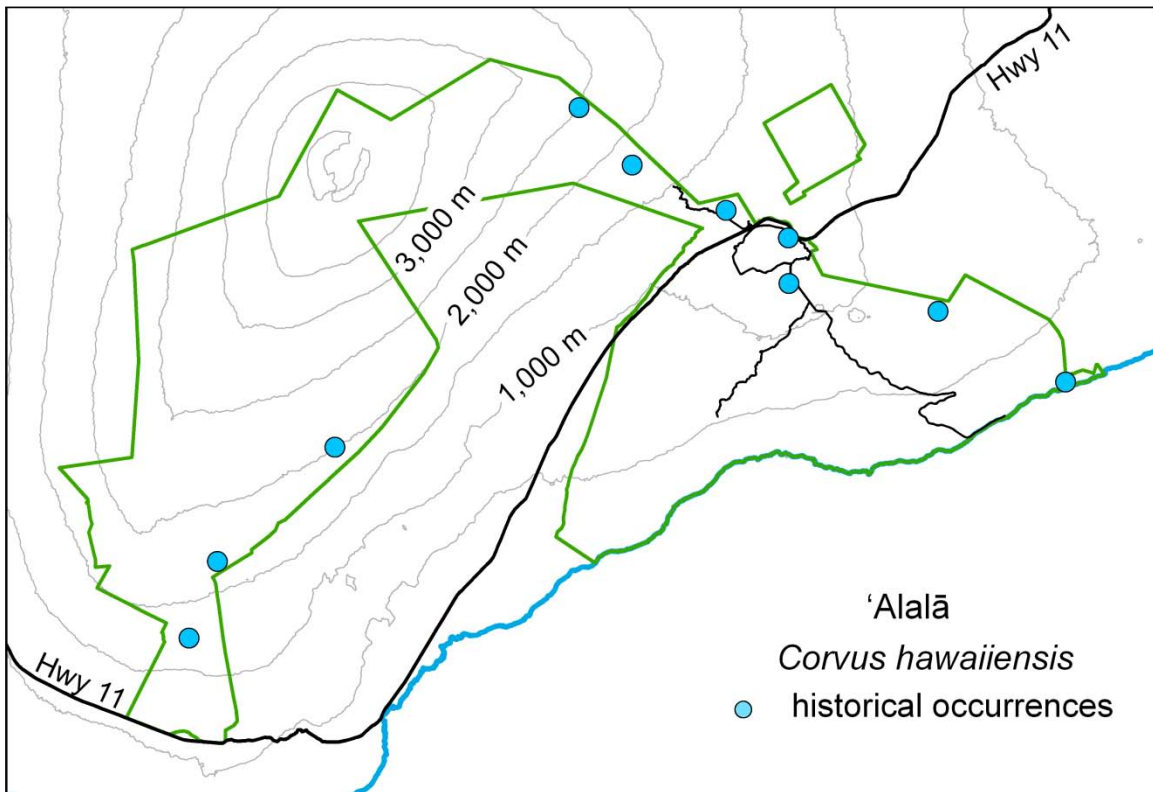
HABITS: Active at dawn and dusk, more likely than barn owl to be seen in the day. The pueo is mainly a predator of rodents and insects, but the owl occasionally takes birds and is implicated as a robber of chicks from bird nests. **The voice of the pueo is a muffled bark, except during courtship, when the male's song is a series of low hoots.**

SIMILAR SPECIES: The introduced barn owl is often mistaken for the pueo, but it is larger and lighter in color, with dark eyes and no streaking on the underparts.

THREATS: Mammalian predators are a threat to this ground-nesting owl (Scott *et al.* 1986). Competition with the larger, non-native barn owl may also be a threat to **the pueo's survival but has not been studied.**

MANAGEMENT/RESTORATION STRATEGIES: Control of mammalian predators would likely benefit this species. Conversion of pastures to forest would decrease habitat for the pueo.

REMARKS: This is the pre-eminent land bird in Hawaiian culture and was widely adopted as an `aumakua (a family or personal god/spiritual guide in Hawaiian culture). The pueo is possibly a recent arrival in the Hawaiian Islands, as it is known from the fossil record only on Kaua`i, where remains were excavated from the upper levels of a sinkhole and cave system (Burney *et al.* 2001).



'Alalā, Hawaiian crow, *Corvus hawaiiensis*
Photo: Paul Banko, USGS, PIERC

COMMON NAME: **`Alalā, Hawaiian crow**
SCIENTIFIC NAME: *Corvus hawaiiensis*
FAMILY: Corvidae (Crows and Jays)
SYNONYMS: *Corvus tropicus*
FEDERAL AND STATE STATUS: Endangered, listed in 1967

DESCRIPTION: The **`alalā is larger** than the American crow (*Corvus brachyrhynchos*, not present in Hawai`i) measuring 48 cm long. It is a faded sooty color rather than the glossy black of the more familiar mainland species. The **`alalā is actually more raven-like** and sports a beard. Young birds have bluish eyes, compared with the brown-eyed adults, and the inside of their mouth is pink, rather than black.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Extinct in the wild. Known historically only from the island of Hawai`i where it occurred in the Kona and Ka`ū districts. **In the recent past, the `alalā was** restricted to forests in central Kona (Scott *et al.* 1986), where a few adults survived until 2003. The **`alalā** now survives only in captivity at facilities on Maui and Hawai`i islands operated by the Zoological Society of San Diego. The Hawai`i facility is situated at Keauhou, near HAVO.

HAVO DISTRIBUTION: Extirpated from the park. Last reported from the original section of HAVO near **Kīpuka Puauulu and within the housing area near** park headquarters between 1975 and 1977. Earlier sightings of the crow within HAVO ranged from the seacoast to above 2,440 m (8,000 ft) elevation on Mauna Loa and included sites on the East Rift and Chain of Craters Road. **The `alalā formerly occurred** in and near the Kahuku Unit, where the last birds were heard in 1971 and 1974. The **`alalā** was seen more frequently at Kahuku in the period 1910–1960 (Banko and Banko 1980).

HABITAT: Mainly native forest and wooded pasture, at roughly 305–1,220 m (1,000–4,000 ft) elevation.

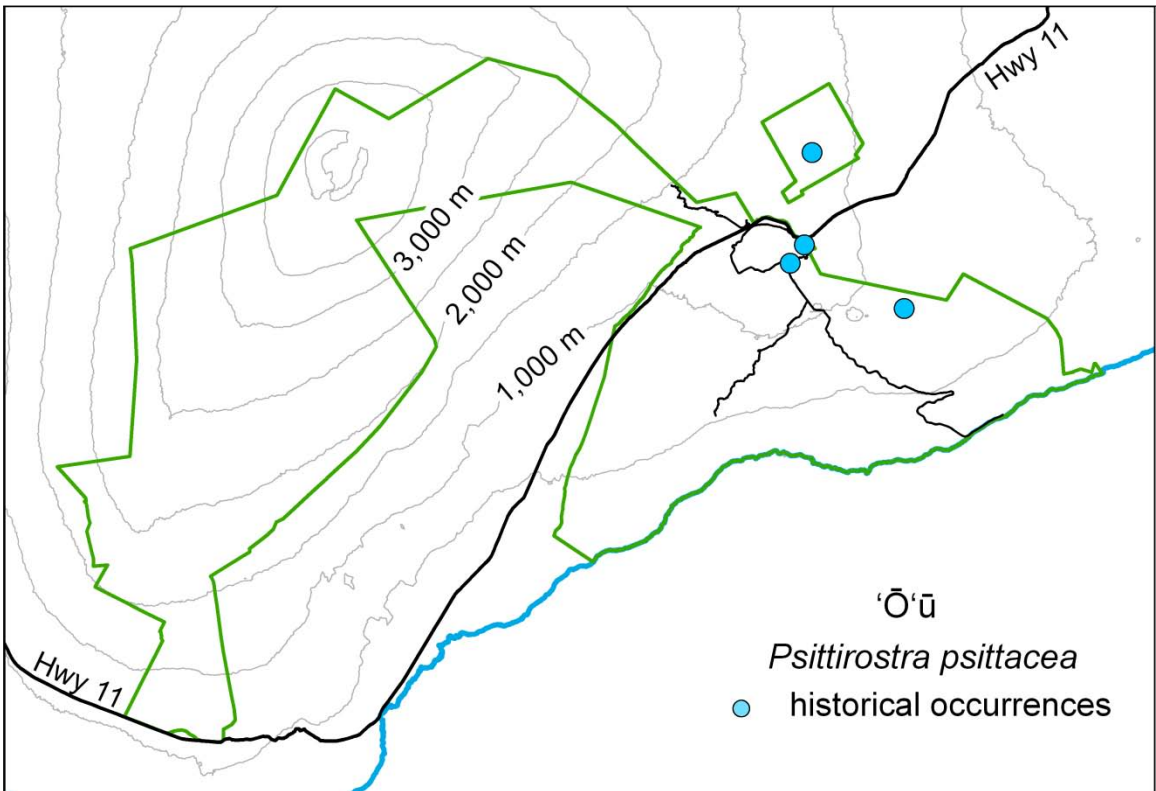
HABITS: Omnivorous, the **`alalā** feeds on nectar from **`ōhi`a** lehua flowers, fruits, insects, nestling birds, and carrion. The social unit is a pair together with young-of-the-year if the adults were successful nesting. Outside the nesting season, **`alalā** formed flocks, although with so few birds left, these noisy gatherings are but a memory. The nest is a bulky cup of branches and twigs placed in the crown of an **`ōhi`a** lehua. The voice includes a surprising range of yodels, screams, and other calls, including the expected cawing (Banko *et al.* 2002).

SIMILAR SPECIES: None, but occasional recent reports of **`alalā in the** park are surely mistaken. Common mynas (*Acridotheres tristis*) silhouetted at a distance have been identified as **`alalā**, as have glimpses of kalij pheasants (*Lophura leucomelanos*).

THREATS: A host of threats have gradually dragged this resourceful species to the brink of extinction. Much of its habitat has been converted to pastures. Cats and mongooses have taken some **`alalā**, especially fledglings. Like many other native birds, **`alalā** are susceptible to two debilitating and often fatal diseases, avian malaria and avian pox, both transmitted by night-flying mosquitoes. Some of the last wild birds may have been picked off by **`io**. In addition to these ecological threats, the reproduction of the **`alalā is severely limited by its low hatching rate, for unknown reasons** (Banko 2009, U.S. Fish and Wildlife Service 2009b).

MANAGEMENT/RESTORATION STRATEGIES: Recovery attempts are complex and politically charged. At the time this book was being written, management was focused almost entirely on building the captive flock, with future releases to be determined.

REMARKS: It is debatable whether HAVO offers enough suitable habitat to ensure the success of any future releases.



'Ō'ū, *Psittirostra psittacea*

Plate from Wilson and Evans 1890–1899. *Aves Hawaiienses: The Birds of the Sandwich Islands.*

COMMON NAME: `ō`ū

SCIENTIFIC NAME: *Psittirostra psittacea*

FAMILY: Fringillidae (Finches), Sub-family Drepanidinae (Hawaiian Honeycreepers)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered, listed in 1967; possibly extinct

DESCRIPTION: A finch-like honeycreeper with parrot-green plumage and pale pink, hooked bill. Males have a bright yellow head, whereas females and young are green above and white below. It is 17 cm long.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Possibly extinct, though formerly found on Kaua`i, O`ahu, Moloka`i, Lāna`i, Maui, and Hawai`i. The last few sightings were from the Alaka`i Swamp on Kaua`i and the `Ōla`a region of Hawai`i (Gorresen *et al.* 2009). The last verified sighting was in 1989, on Kaua`i (Banko and Banko 2009). The species will remain listed as a living species on the American **Ornithologists' Union Checklist (2010) until enough evidence indicates that** the species is extinct, which may take many years.

HAVO DISTRIBUTION: Extirpated in the park; possibly extinct on the island of Hawai`i. The species was observed rarely in forests of the East Rift from 1936–1940 and in `Ōla`a Forest from 1938–39 (Baldwin 1941). A few `ō`ū were noted within `Ōla`a **Forest and near Nāhuku (Thurston Lava Tube) from 1959–1961**, but none was detected at Makaopuhi and Nāpau (Dunmire 1962). Later detections in the park were **in `Ōla`a Forest from 1974–1975, Nāhuku in 1974, and southeast of** park headquarters in 1977 (Banko 1986). The last confirmed sighting of `ō`ū in HAVO was in `Ōla`a Forest in 1987 (Reynolds and Snetsinger 2001).

HABITAT: The habitat of the `ō`ū was mainly rain forest, especially at lower elevations, but the bird wandered widely.

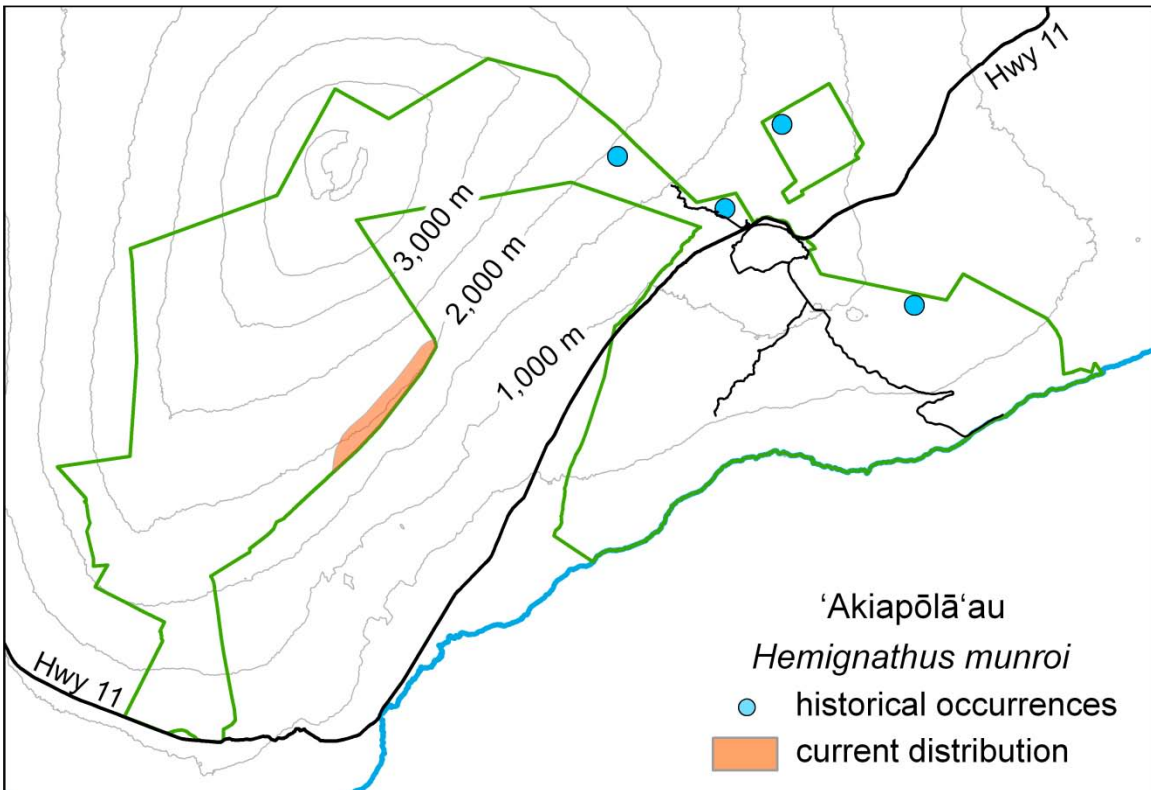
HABITS: The `ō`ū fed on fruit, insects, and nectar. The fruit of `ie`ie was a favorite food (Perkins 1903). Nothing is known about `ō`ū nesting habits. The song was a rich, canary-like song of warbles and trills.

SIMILAR SPECIES: Some house finches (*Carpodacus mexicanus*) have a yellow head, but the body is brown and streaked, rather than evenly green.

THREATS: The `ō`ū probably suffered from the same gamut of threats that affect other forest birds today: loss of habitat and introduced diseases and predators (Scott *et al.* 1986). Although it was a widespread and adaptable species, in the end the `ō`ū may have been particularly susceptible because it favored lower elevations where these threats were, and continue to be, more acute.

MANAGEMENT/RESTORATION STRATEGIES: None at this late stage.

REMARKS: Further surveys may be required to confirm the status of the `ō`ū.



'Akiapōlā'au, *Hemignathus munroi*
Photo: © Jack Jeffrey

COMMON NAME: **`Akiapōlā`au**

SCIENTIFIC NAME: *Hemignathus munroi*

FAMILY: Fringillidae (Finches), Sub-family Drepanidinae (Hawaiian Honeycreepers)

SYNONYMS: *Heterorhynchus wilsoni*

FEDERAL AND STATE STATUS: Endangered, listed in 1967

DESCRIPTION: A yellow-green Hawaiian honeycreeper with very long down-curved bill. The lower bill is actually much shorter and straight—a unique configuration among birds. The male has a yellow-green head and yellow breast; in the female and young birds these parts are greenish. This bird is 14 cm long.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island, at elevations above 1,525 m (5,000 ft). Most remaining **`akiapōlā`au are at Hakalau Forest National Wildlife Refuge, Kūlani, Keauhou Ranch, and Ka`ū and Kapāpala Forest Reserves (Gorresen *et al.* 2009).**

HAVO DISTRIBUTION: This species is now found in HAVO only at the Kahuku Unit near the boundary **with the Kapāpala and Ka`ū Forest Reserves.** Here, a few birds live on the outskirts of a population of approximately 1,100 **`akiapōlā`au** mainly in the two forest reserves (Tweed *et al.* 2007). The species is extirpated in the original section of HAVO but is locally common in koa plantations on neighboring Keauhou Ranch. **`Akiapōlā`au** occurred historically **until the 1940s in Kīpuka Puaulu and the Mauna Loa Strip (Baldwin 1941).** There were no observations from the Mauna Loa Strip after 1950 until a final sighting in 1978 (Banko 1984a). As late as 1965, **`akiapōlā`au** were observed in the East Rift between **Makaopuhi and Nāpau craters, and the bird was last seen in `Ōla`a Forest in 1974 (Banko 1984a).** Prior to Western contact, **`akiapōlā`au** probably lived wherever there was forest.

HABITAT: **`Akiapōlā`au** prefer mixed koa/**`ōhi`a** lehua forests. Recently it has been discovered that **`akiapōlā`au** favor groves of young koa trees (Pejchar *et al.* 2005), and the species benefits when pastures are converted to koa forest.

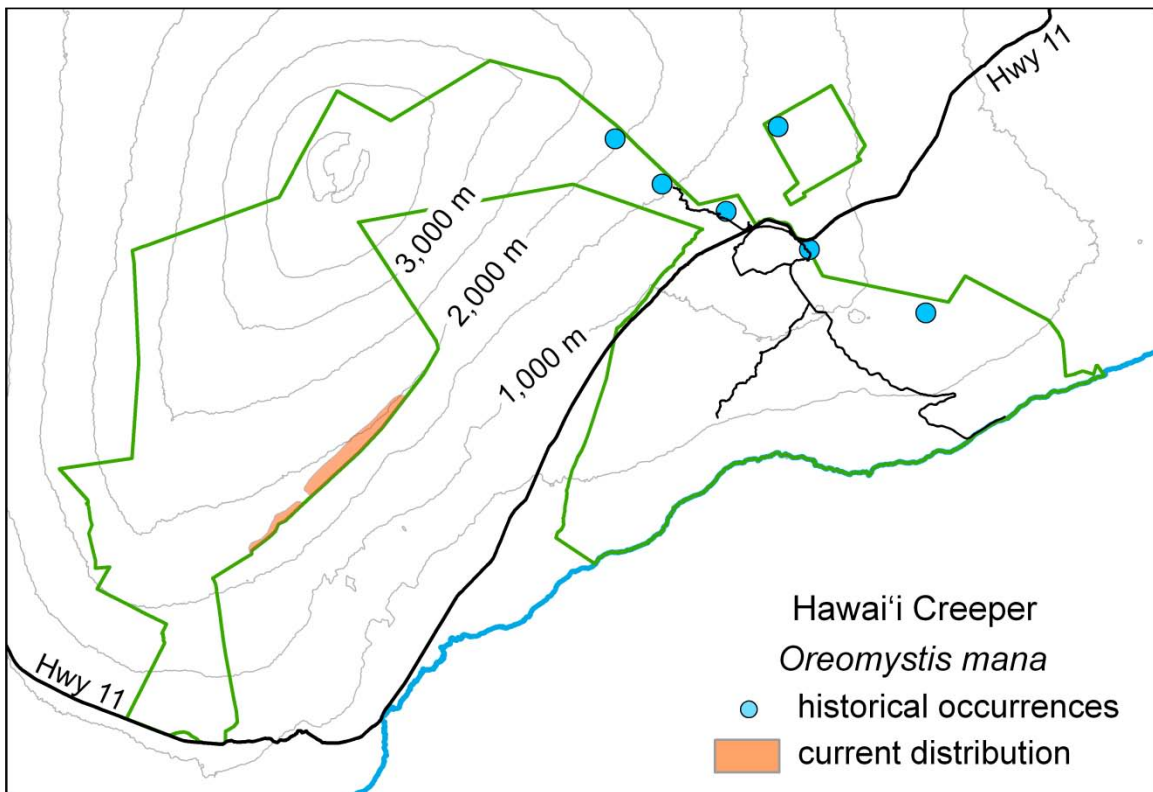
HABITS: This bird feeds on small invertebrates found mainly under bark and epiphytes. Its prey includes caterpillars, spiders, and beetle larvae. Prey is often located by tapping on a tree branch with the lower bill. The bird exposes its quarry by chiseling away cover with the lower bill or by simply probing hiding places with the upper bill. The nest is typically situated in an **`ōhi`a** tree below the treetop foliage and is composed of bark, twigs, and fiber. Usually only one spotted egg is laid and incubated by the female. The male assists by bringing food and feeding the growing nestling. After fledging, the young bird stays with its parents for many months, often until they go to nest again the following year. The song is a halting warble (Pratt *et al.* 2001).

SIMILAR SPECIES: May be confused with Hawai`i **`amakihi** (*Hemignathus virens*); however, the **`amakihi** bill is much shorter, and the lower bill is the same length as the upper bill.

THREATS: Loss and fragmentation of habitat (Scott *et al.* 1986), avian diseases, and small mammalian predators are the main threats. The effect of these threats is worsened for the **`akiapōlā`au** because the **bird's low fecundity necessitates** that adults live a long time and have a high level of nesting success (Pratt *et al.* 2001).

MANAGEMENT/RESTORATION STRATEGIES: The main strategy is to increase habitat at elevations high enough to avoid transmission of avian diseases by mosquitoes. Reducing populations of mammalian predators should increase the reproduction and survival of these birds. **Restoring forest at higher elevations of the Kahuku Unit (and Ka`ū Forest Reserve) would improve habitat for the `akiapōlā`au.** This bird may someday reappear in Mauna Loa Strip as revegetation of upper Keauhou Ranch proceeds, or the species could be reintroduced.

REMARKS: The name is reduced from **`akihi po`o lā`au** or **"little bird that pecks at wood."**



Hawai'i creeper, *Oreomystis mana*
Photo: © Jack Jeffrey

COMMON NAME: **Hawai`i creeper**

SCIENTIFIC NAME: *Oreomystis mana*

FAMILY: Fringillidae (Finches), Sub-family Drepanidinae (Hawaiian Honeycreepers)

SYNONYMS: *Loxops mana*, *Loxops maculatus mana*; Olive-green creeper

FEDERAL AND STATE STATUS: Endangered, listed in 1975

DESCRIPTION: A plain, olive-green honeycreeper that is paler below. This species has a distinctive black mask. Note the short, straight bill. Males and females look alike and are about 11 cm long.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island; now restricted to high elevations (above 1,525 m or 5,000 ft) on windward Mauna Kea and Mauna Loa, **Kona, Ka`ū**, and the north slope of Hualālai (Gorresen *et al.* 2009).

HAVO DISTRIBUTION: **The Hawai`i creeper's distribution in HAVO now includes only the Kahuku Unit, in forests above and adjacent to the Ka`ū Forest Reserve. This Ka`ū population is estimated to be about 2,300 birds (Tweed *et al.* 2007).** The species is now extirpated from the original section of HAVO but is still present on nearby Keauhou Ranch. Occasional park reports may be of birds that have wandered over from Keauhou, but more likely they are misidentifications of Hawai`i `amakihi. In 1938–1940, the Hawai`i creeper was rare in East Rift forests and uncommon at several sites in koa forests of Kīpuka Kulalio and Kīpuka Puaulu, on Mauna Loa (Baldwin 1941, 1953). By the late 1960s, the Hawai`i creeper had disappeared from the Mauna Loa Strip. **The last definitive sightings on Kīlauea were near Nahuku (Thurston Lava Tube) in 1952 and the trail below Volcano House in 1958 (Banko 1984b), and the species was last observed in `Ōla`a Forest in the early 1960s (Dunmire 1962).** The last sighting in Puna District was in 1973 (Banko and Banko 2009). Originally, the Hawai`i creeper was probably distributed throughout forests in the park.

HABITAT: Currently favors undisturbed `ōhi`a lehua and koa/`ōhi`a forests (Scott *et al.* 1986). Originally the Hawai`i creeper could have inhabited most forest types in the park.

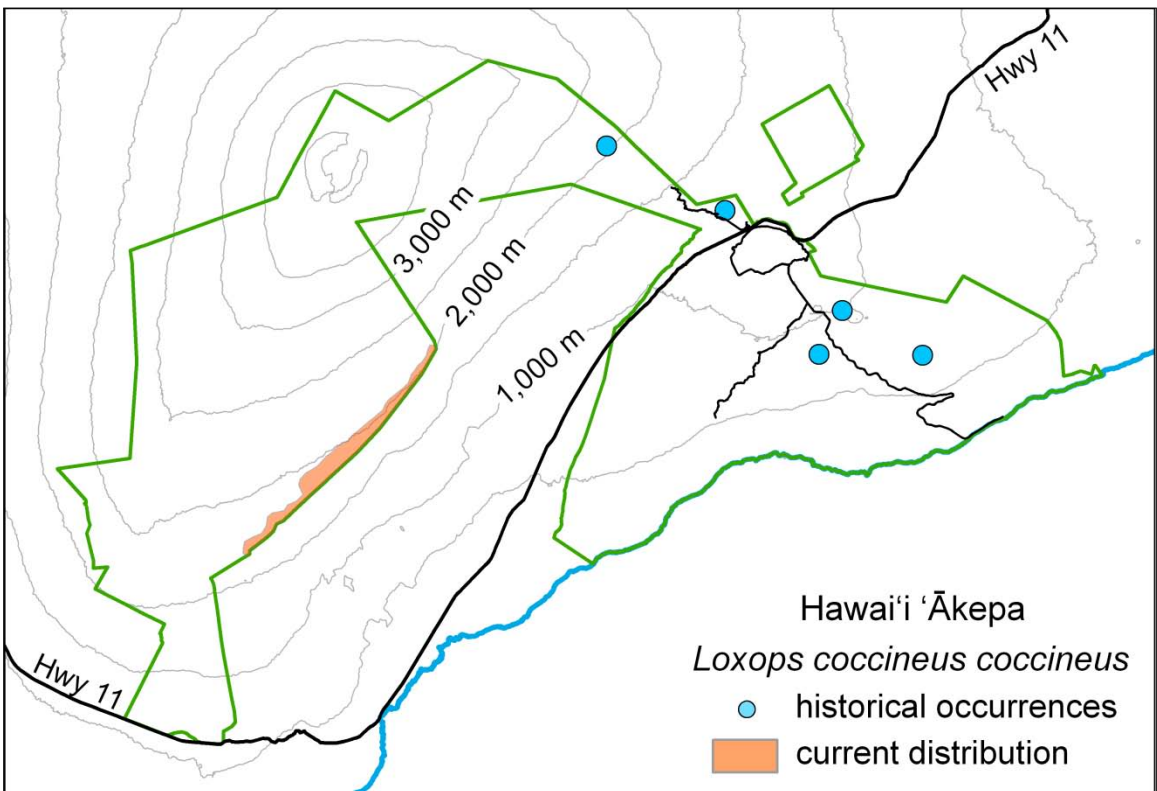
HABITS: Feeds on insects and spiders gleaned from branches and twigs. Forages by creeping along branches, often in precarious-looking positions. The small cup-shaped nest is built into a branch. The female lays and incubates two spotted eggs. The male assists by feeding the female and the growing chicks. The song is a rapid trill declining in volume (Lepson and Woodworth 2002).

SIMILAR SPECIES: Distinguished with study and practice from Hawai`i `amakihi (*Hemignathus virens*) by its shorter, straighter bill and by subtle color differences, such as the black mask and whitish throat.

THREATS: Loss of habitat, avian disease, and small mammalian predators are the main threats.

MANAGEMENT/RESTORATION STRATEGIES: As for other forest birds, ongoing recovery and restoration of forests on the Mauna Loa Strip could eventually lure Hawai`i creepers back to this section of the park. Reducing predator numbers may be necessary to sustain any new population. Removal of feral ungulates and protection of current habitat in montane wet forests of Kahuku Unit would likely benefit this species, as well as other forest birds (U.S. Fish and Wildlife Service 2006).

REMARKS: No Hawaiian name was ever recorded for this species.



Hawai'i 'Ākepa, *Loxops coccineus* subsp. *coccineus*
Photo: © Jack Jeffrey

COMMON NAME: **Hawai`i `ākepa**

SCIENTIFIC NAME: *Loxops coccineus* subsp. *coccineus*

FAMILY: Fringillidae (Finches), Sub-family Drepanidinae (Hawaiian Honeycreepers)

SYNONYMS: `Akakane

FEDERAL AND STATE STATUS: Endangered, listed in 1970

DESCRIPTION: The smallest Hawaiian honeycreeper in or near the park, with a short bill and somewhat forked tail. It is only 10 cm long. The bill is slightly twisted, so that the mandible tips cross each other. Males are bright orange, whereas females and young birds are gray-green. Males take several years to attain their bright plumage, an unusually long time for such a small bird.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Island of Hawai`i. The largest population is centered at **Hakalau Forest National Wildlife Refuge, but populations also remain in Ka`ū, Kona, and on Hualālai** (Gorresen *et al.* 2009). A different subspecies inhabited Maui but is now likely extinct (*L. coccineus ochraceus*).

HAVO DISTRIBUTION: The second largest known population, composed of 2,600 birds, lives in Kahuku Unit and in the upper-**elevation forests of the Ka`ū Forest Reserve (Tweed *et al.* 2007)**. Extirpated from the original section of HAVO, the species survives on neighboring Keauhou Ranch. Occasional reports from the Mauna Loa Strip are perhaps birds that have wandered over from Keauhou or are misidentifications. In the 1890s, the `ākepa was common in `ōhi`a lehua forests near the summit of Kīlauea and in the region that is now the Mauna Loa **Strip, Kīpuka Puauulu, and adjacent Keauhou**. By the 1930s, the bird had disappeared from the Mauna Loa Strip (Baldwin 1941) but was still present in dry **woodlands near `Āinahou, as well as in the eastern section** of the park near Pu`u Huluhulu and the Kalapana Trail (Banko 1984b). Hawai`i `ākepa was lost from HAVO around 1950 (Banko 1984b), until the addition of Kahuku to the park in 2003.

HABITAT: Now restricted to koa/`ōhi`a lehua forests at high elevations, generally above 1,525 m (5,000 ft). Originally, the species could have inhabited all forests on the island.

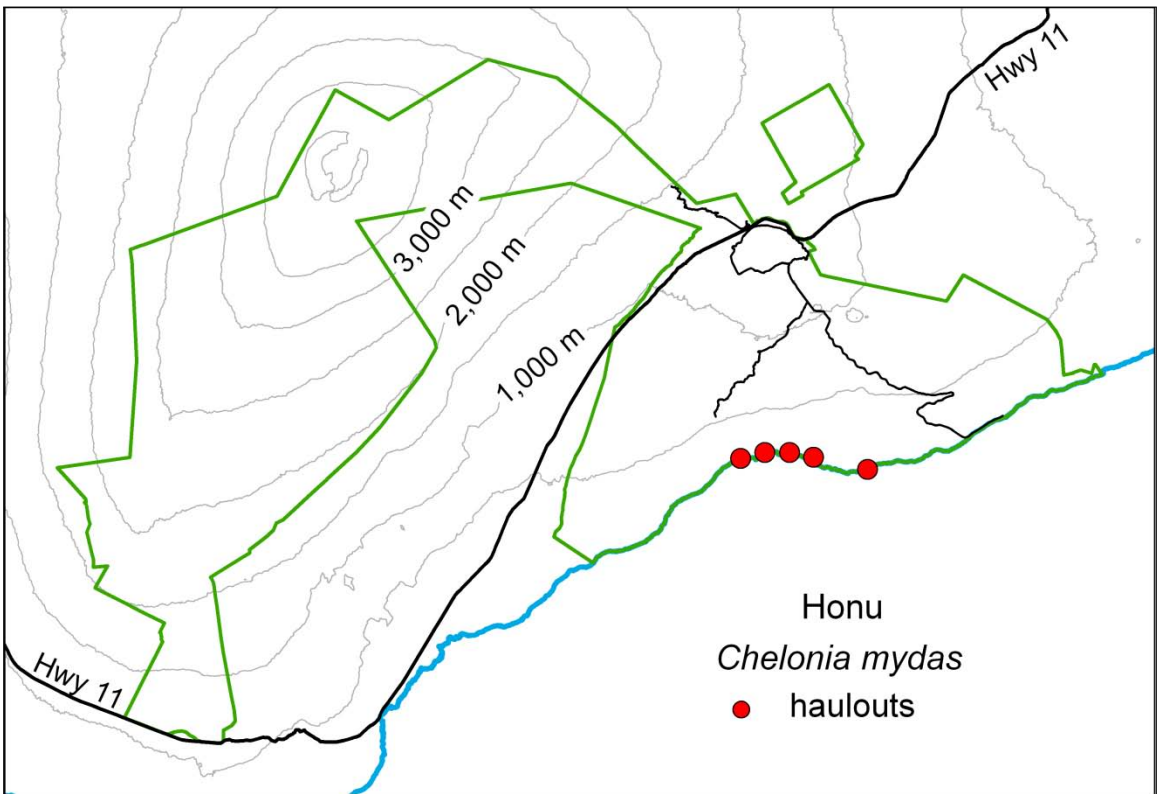
HABITS: Hawai`i `ākepa feed on small insects and spiders living in the terminal leaves and leaf buds, particularly of `ōhi`a lehua trees. They use their peculiar cross bills to pry open leaf buds. `Ākepa nest in tree hollows, in which they build a regular cup-shaped nest and lay two spotted eggs. The song is a trill, often changing rhythm in the middle (Lepson and Freed 1997).

SIMILAR SPECIES: The green Hawai`i `amakihi (*Hemignathus virens*) and Hawai`i creeper (*Oreomystis mana*) are both noticeably larger and have longer bills than the female `ākepa; **the adult male's orange plumage is unmistakable.**

THREATS: The same as for Hawai`i creeper, although the Hawai`i `ākepa depends more on large trees for nesting (Sincock and Scott 1980). One recent study presented evidence for decreases **in `ākepa due** to competition with the Japanese white-eye (Freed *et al.* 2008).

MANAGEMENT/RESTORATION STRATEGIES: Restoration of forests at high elevation is critical to the recovery of the Hawai`i `ākepa, **particularly as the Ka`ū population is so important to the species.** Reducing numbers of small mammals would likely relieve depredations. It is debatable whether there is currently adequate habitat for this species on the Mauna Loa Strip, where large `ōhi`a lehua trees are in short supply.

REMARKS: The name `ākepa means "sprightly" (Pukui and Elbert 1971).



Honu, Green sea turtle, *Chelonia mydas* subsp. *agassizi*
Photo: NPS, HAVO, Hawksbill Turtle Project

COMMON NAME: **Honu, Green sea turtle**

SCIENTIFIC NAME: *Chelonia mydas* subsp. *agassizi*

FAMILY: Cheloniidae (Sea Turtles)

SYNONYMS: None

FEDERAL AND STATE STATUS: Threatened, listed in 1978 (Endangered in Florida)

DESCRIPTION: The honu's shell can grow to 1 m in length. This turtle is olive-green above, usually variegated with brown, reddish-brown, and black and is whitish or cream-colored below. The head has a single pair of scales between the eyes and four or more scales behind the eye. The upper jaw is rounded and does not project to form a hooked beak. The shell is subcircular to heart-shaped with the lateral edges not upturned, and there are four costal shields per side. Hatchlings are shiny black above, white below, about 5 cm long (Cogger 1992).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: This sea turtle inhabits shallow waters of all main Hawaiian Islands. The nesting grounds are in Northwestern Hawaiian Islands, primarily at French Frigate Shoals. The species is pantropical in distribution, but the subspecies *agassizi* occurs in the eastern Pacific Ocean, including Hawai'i (McKeown 1996).

HAVO DISTRIBUTION: Green sea turtles are commonly observed along coastal waters of HAVO; less often they are seen resting and basking at park beaches. There is no population estimate for HAVO.

HABITAT: Honu are seen in water near the shore throughout the Hawaiian Islands, where they feed on algae (limu) growing on rocky coasts. Here, they may be tossed about by the waves but seem to be protected from damage by their hard shells and powerful flippers. They nest on sandy beaches.

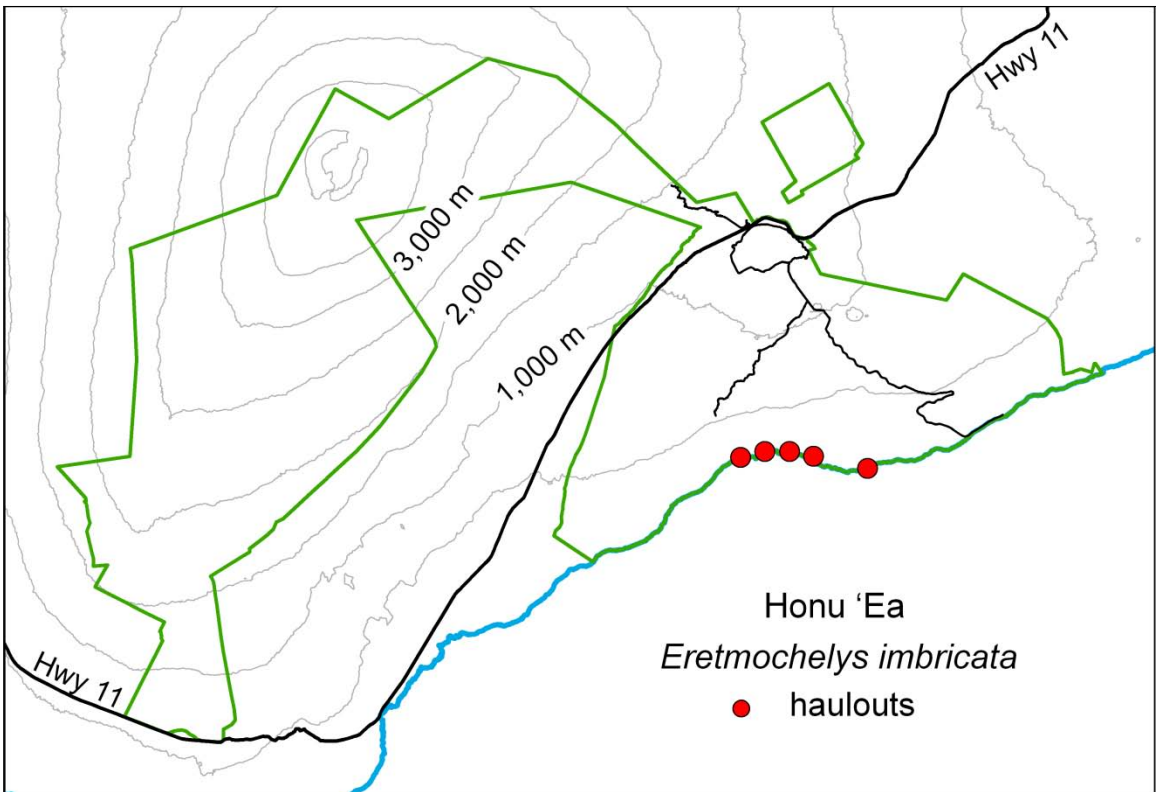
HABITS: When young, green sea turtles are at first carnivorous, feeding on jellyfish and other invertebrates. Adults are almost entirely herbivorous. Females reach sexual maturity at 20–50 years (National Oceanic and Atmospheric Administration [NOAA] 2010b). They swim as much as 1,280 km from the main Hawaiian Islands to nesting beaches at French Frigate Shoals. Females lay from 50 to 150 round, parchment-shelled eggs in a large pit they excavate with their front and back flippers. After covering the pit with sand, the female returns to the sea, and the eggs incubate on their own for about two months before they hatch. Hatchling turtles dig out of the nest unassisted and immediately move toward the ocean (McKeown 1996).

SIMILAR SPECIES: The green sea turtle may be distinguished from the hawksbill turtle by the lack of a pointed beak, a single pair of prefrontal scales between the eyes (versus two pairs in hawksbills), and its smooth shell edges lacking teeth. The rare, huge leatherback turtle (*Dermochelys coriacea*) is not seen in shallow water, but may be recognized by its shell with prominent longitudinal ridges.

THREATS: Poaching for food (meat and eggs) and the shell (used for jewelry and combs); incidental catch in nets, long lines, and other fishing gear; ingestion of plastic marine debris; pollution; development of nesting beaches; and predation of eggs and hatchlings by mongooses, dogs, and cats. A disease called fibropapillomatosis also affects some green turtles in Hawai'i (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998a, NOAA 2010b).

MANAGEMENT/RESTORATION STRATEGIES: The long stretch of uninhabited park coastline to some extent isolates the marine turtles from most human impacts. Turtles in HAVO are protected by all applicable laws, and the Natural Resources Management Division has an active program to monitor turtles and reduce predators at coastal sites.

REMARKS: The green sea turtle is readily seen at many sites on the island of Hawai'i such as Punalu'u Black Sand Beach, south of HAVO. While turtles are numerous here and seemingly unconcerned about human presence, they should not be closely approached or touched.



Honu 'Ea, Hawksbill turtle, *Eretmochelys imbricata* subsp. *bissa*
 Photo: NPS, HAVO, Hawksbill Turtle Project

COMMON NAME: **Honu`ea, Hawksbill turtle**
SCIENTIFIC NAME: *Eretmochelys imbricata* subsp. *bissa*
FAMILY: Cheloniidae (Sea Turtles)
SYNONYMS: None
FEDERAL AND STATE STATUS: Endangered, listed in 1970

DESCRIPTION: The shell of the hawksbill turtle reaches 1 m in length. It is olive-green or brown above and whitish below, variegated with red-brown, dark-brown, and black markings. There are two pairs of scales between the eyes and three scales behind the eye. The upper jaw projects forward to form a pointed beak. The shell is narrowly heart-shaped with four large scales or shields per side and strongly overlapping dorsal scutes. Hatchlings are blackish above, dark or black below (Cogger 1992).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Rare in waters off O`ahu, Moloka`i, Maui, and Hawai`i. The hawksbill is found throughout tropical and warm temperate seas of the world.

HAVO DISTRIBUTION: **Hawksbill turtles nest at `Āpua Point, Keauhou, and Halapē within the park.** Sightings may be made at almost any point along the HAVO coast.

HABITAT: Honu`ea, or hawksbill turtles, range from inshore reefs to the open ocean; they bask and nest on sandy beaches with strand vegetation. Low numbers of this endangered turtle are found in waters off O`ahu, Moloka`i, Maui, and Hawai`i, **with 90% of documented nests occurring on Hawai`i's south coast.**

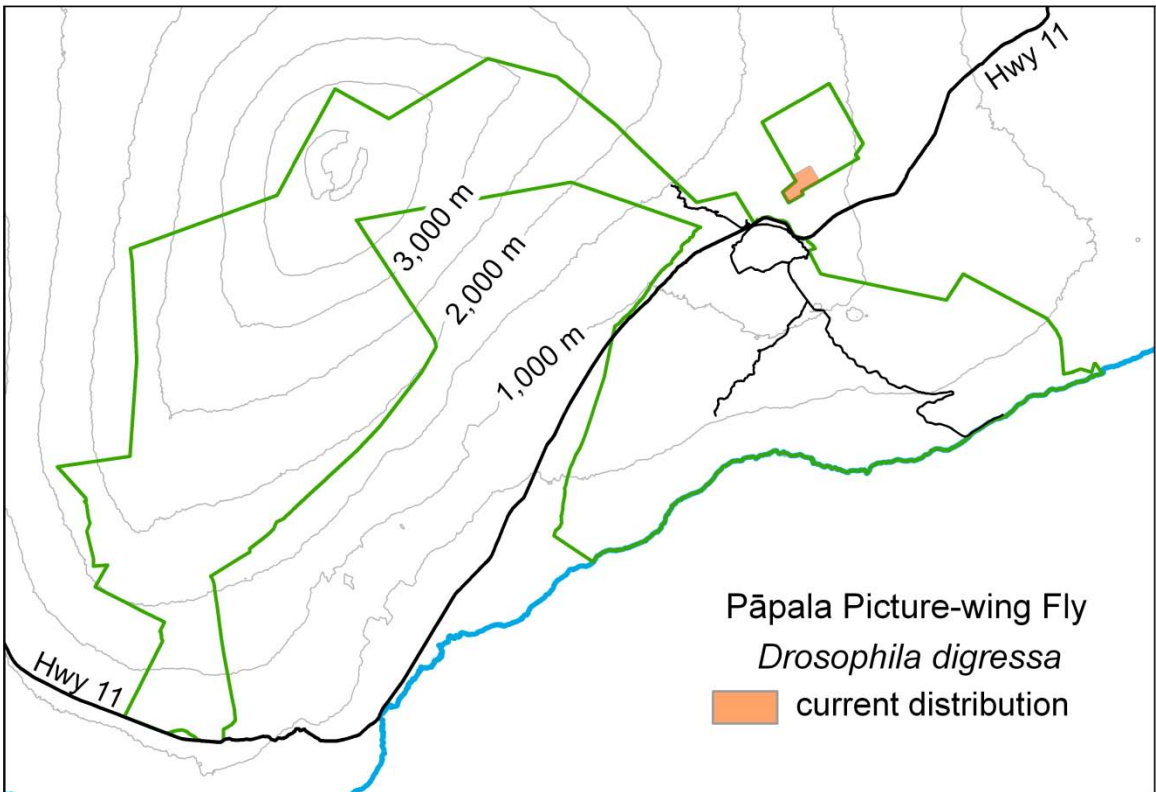
HABITS: The hawksbill favors coral reefs, where it feeds on sponges, crabs, fish, sea urchins, shellfish, seaweed, and bottom-dwelling invertebrates. The females come to shore at night and lay up to 175 small, round, white eggs per clutch (McKeown 1996, NOAA 2010c).

SIMILAR SPECIES: The hawksbill turtle is distinguished from the more common green turtle by its beaked upper jaw, two pairs of prefrontal scales between the eyes (versus one pair in the green turtle), and serrated shell margin and overlapping scutes on the top shell or carapace.

THREATS: Loss of coral reefs; poaching for food, tortoiseshell jewelry, oil, and other uses; incidental catch in long lines and drift nets; ingestion of plastic marine debris; pollution; development of nesting beaches (NOAA 2010c); and predation of eggs and hatchlings by mongooses, dogs, and cats are all threats to the hawksbill turtle. Artificial lighting on beaches may alter the behavior of females attempting to nest (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1998b).

MANAGEMENT/RESTORATION STRATEGIES: HAVO has had a long-term nesting observation program for more than 20 years (Seitz *et al.* 2012). Between 1989 and 2006, more than 600 nests were protected, and over 67,000 hatchlings were observed reaching the ocean (Seitz *et al.* 2006). Visitors are informed that camp lighting should be kept to a minimum, and park staff members manage their camp lights to minimize turtle disorientation.

REMARKS: Most sightings of turtles from HAVO coastlines are of the honu, or green sea turtle.



Pāpala picture-wing fly, *Drosophila digressa*
Photo: Karl Magnacca, University of Hawai`i at Hilo

COMMON NAME: **Pāpala picture-wing fly**

SCIENTIFIC NAME: *Drosophila digressa*

FAMILY: Drosophilidae (Pomace Flies)

SYNONYMS: None

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: About the size of house flies, the Hawaiian picture-wings are giants compared to their common cousin, the fruit fly, which is frequently studied in classrooms. Adult males of the **pāpala** picture-wing, which are about 7 mm long, are typical of many other picture-wings because of their characteristic spotting on the wings and back. The spots on the wing-tips of this picture-wing are fused giving them an **"ink-dipped" appearance, and the spots at mid-wing almost form a bar**. This picture-wing also has a distinctive pale stripe down the midline of the back (or thorax) (Hardy and Kaneshiro 1968).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: The **pāpala** picture-wing fly is unique to the island of Hawai`i. Most of the recent sightings of this fly are from Hawai`i Volcanoes National Park.

HAVO DISTRIBUTION: The **pāpala** picture-wing fly has been recorded during surveys of **Ōla`a Forest** from the 1970s to the present, although in declining numbers (Carson 1986). It should be looked for in other areas where its host plant is found. Its range probably once extended into moist forests, such as **Kīpuka Puauulu**.

HABITAT: Currently restricted to montane wet forests containing its host plant, **pāpala**.

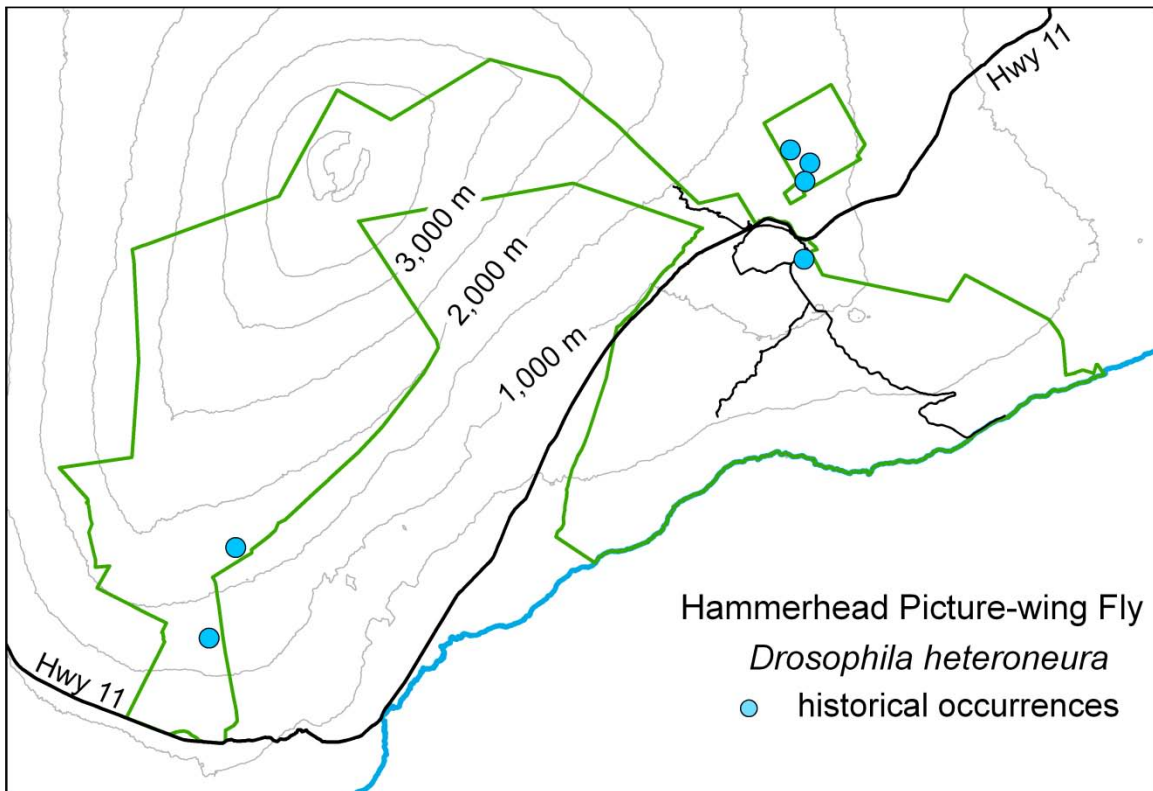
HABITS: The **pāpala** picture-wing completes its life cycle of egg-laying, larval development, and pupal dormancy in rotting branches **of pāpala** plants, with which it is closely associated (Montgomery 1975, Carson 1976).

SIMILAR SPECIES: Many other picture-wings often display seven spots on the wings, but this species has **"ink-dipped" wings. The pāpala picture-wing has more spotting on the wings than Mull's** picture-wing fly (*D. mulli*), but lacks the distinctive central right-angle markings of the hammerhead picture-wing fly (*D. heteroneura*).

THREATS: In addition to feral pigs and cattle, a small beetle, the black twig borer, attacks host plants of this picture-wing. The western yellowjacket wasp preys on picture-wing flies and may limit this fly's distribution to wetter forests where the wasps are not common (Foote and Carson 1995). These wasps are generalist predators that reach very high densities in montane native forests.

MANAGEMENT/RESTORATION STRATEGIES: The **pāpala** picture-wing fly is a candidate for protection under the Endangered Species Act. Suppression of alien yellowjacket wasps in moist forests, where its host plant occurs, may be necessary for success in any recovery program for this and other Hawaiian picture-wing flies. Restoration of habitat corridors between montane wet and moist forests that target picture-wing host plants may allow this and other species of rare picture-wing flies to expand their distribution within HAVO.

REMARKS: Adults of this species are attracted to fermenting banana, yeast, and mushroom baits, but **other records have been obtained by collection of rotting branches of pāpala that are held** in the lab until adults emerge.



Hammerhead picture-wing fly, *Drosophila heteroneura*
Photo: William P. Mull © Bishop Museum

COMMON NAME: **Hammerhead picture-wing fly**
SCIENTIFIC NAME: *Drosophila heteroneura*
FAMILY: Drosophilidae (Pomace Flies)
SYNONYMS: None
FEDERAL AND STATE STATUS: Endangered, listed in 2006

DESCRIPTION: Adult males of the hammerhead picture-wing fly are 7 mm long and distinguished by **their broad heads and eye sockets, giving them a “hammer-headed” appearance. When they gather to mate, competing males engage in head-butting bouts much like mountain goats. In contrast, females have smaller, rounded heads. Both males and females are light or golden brown in color with dark brown or black markings on the body and wings. This species has a distinctive right-angle marking (an “L” on the right wing) at the center of the wing (Perkins 1910).**

DISTRIBUTION IN THE HAWAIIAN ISLANDS: The hammerhead picture-wing fly is unique to the island of Hawai`i. It was formerly one of the most widespread species of picture-wings, ranging over suitable habitat across most of the island. The only recent sightings of the hammerhead picture-wing fly are from the Kona Unit of Hakalau Forest National Wildlife Refuge (Foote 2000).

HAVO DISTRIBUTION: This picture-wing fly is apparently extirpated from HAVO but was observed **regularly in the 1970s and 1980s in `Ōla`a Forest and around Nāhuku (Thurston Lava Tube) in association with large `ōhā (e.g., `ōhā kēpau)** (Carson 1986). It was likely found throughout HAVO wherever large `ōhā occurred, such as at **Kīpuka Puuulu**. Of all the places where this picture-wing was found, it was perhaps most abundant at Kahuku Ranch, now Kahuku Unit of HAVO (Carson *et al.* 1989).

HABITAT: Moist to wet montane forest from about 900 to 1,300 m (2,950–4,265 ft) elevation.

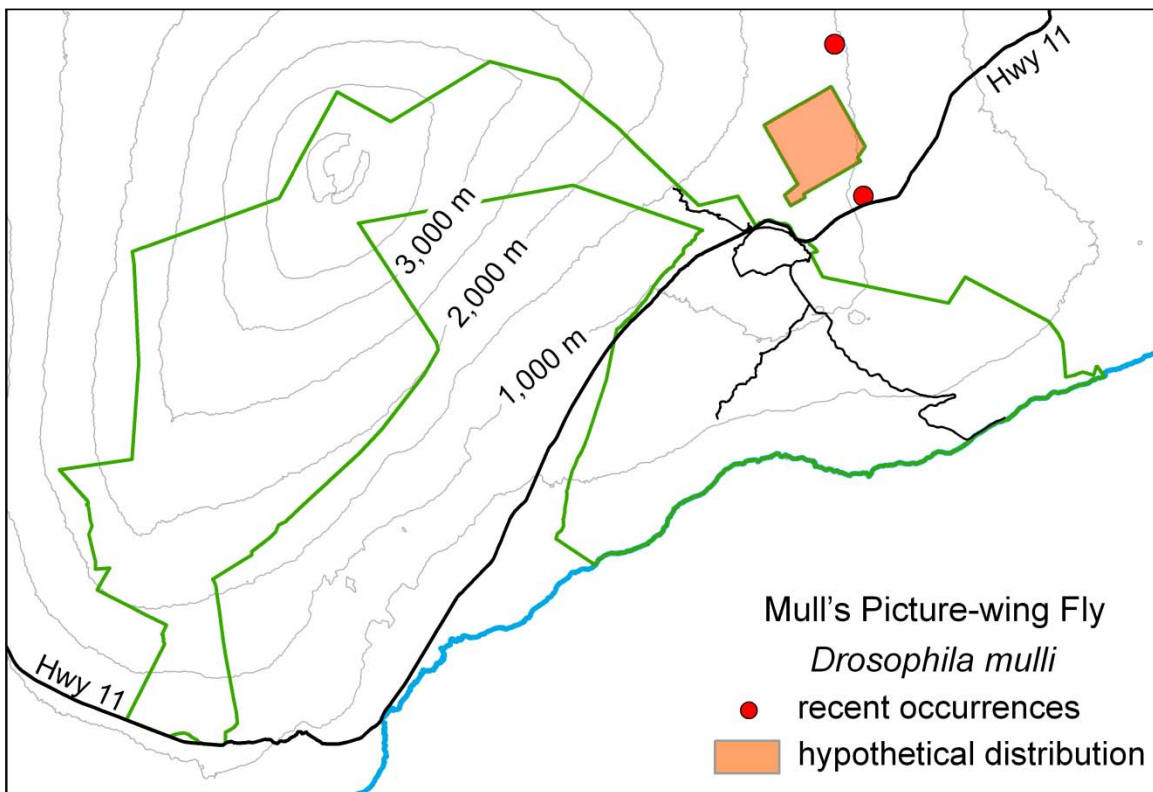
HABITS: Adults can be seen feeding on rotting plants where yeasts and bacteria are present. They complete their life cycle in the **rotting bark of large `ōhā and other lobelioid plants.**

SIMILAR SPECIES: Another large picture-wing fly, *Drosophila silvestris*, has similar body and wing markings, but the males do not have hammer-heads and their faces are darker. These two species overlap in distribution and are interfertile but differ dramatically in their courtship behavior (Carson *et al.* 1989). Instead of head-butting, male *D. silvestris* use their front legs to wrestle each other.

THREATS: The hammerhead picture-wing fly mostly disappeared from the park when the western yellowjacket wasp first arrived in the late 1970s. However, the flies were never common, and losses of host plants to feral cattle, pigs, and mouflon sheep have probably **contributed to the species' scarcity** (Foote and Carson 1995).

MANAGEMENT/RESTORATION STRATEGIES: The hammerhead picture-wing fly is protected under the Endangered Species Act, and critical habitat for this species is currently under review. Suppression of alien yellowjacket wasps may be a consideration in any recovery program for this and other Hawaiian picture-wing flies in moist montane forests. Rare plant restoration programs targeting lobelioids that also monitor for native picture-wing flies may find that the flies naturally recolonize new host plant populations. Additionally, this picture-wing is an ideal candidate for translocation from the Kona Forest Unit of Hakalau Forest National Wildlife Refuge. This picture-wing fly can be readily bred in the laboratory, so captive rearing may play an important role in the reestablishment of this picture-wing in HAVO.

REMARKS: Unlike many listed endangered species, the hammerhead picture-wing fly has an impressive scientific record of study with many published papers, especially in evolutionary biology. This picture-wing fly is also featured in biology text books and popular scientific articles.



Mull's picture-wing fly, *Drosophila mulli*
Photo: William P. Mull © Bishop Museum

COMMON NAME: **Mull's picture-wing fly**

SCIENTIFIC NAME: *Drosophila mulli*

FAMILY: Drosophilidae (Pomace Flies)

SYNONYMS: None

FEDERAL AND STATE STATUS: Threatened, listed in 2006

DESCRIPTION: Adults are 5 mm long and a light golden brown, with darker brown markings over the body and bases of the wings. Wing veins have lighter-colored and fewer markings than many other Hawaiian picture-wing flies (Perreira and Kaneshiro 1990). The larvae of this species have never been described.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: **Mull's picture-wing fly** is one of the rarest species of Hawaiian picture-wings, recorded only from the windward slopes of Mauna Loa on the island of Hawai'i. **Most of the observations come from `Ōla`a Forest Reserve, adjacent to the `Ōla`a Tract of HAVO** (Perreira and Kaneshiro 1990).

HAVO DISTRIBUTION: **Mull's picture-wing fly** has never been recorded within HAVO even though its host plant occurs in the `Ōla`a Forest. **It seems likely that this picture-wing fly may someday turn up within the park's boundaries.**

HABITAT: Most observations of **Mull's picture-wing fly** come from young or sub-adult palms whose **fronds are below and near the height of the surrounding hāpu`u tree fern canopy.** This picture-wing's apparent rarity may actually reflect the difficulty of observing fronds of taller mature palms, and young palms are especially rare in HAVO.

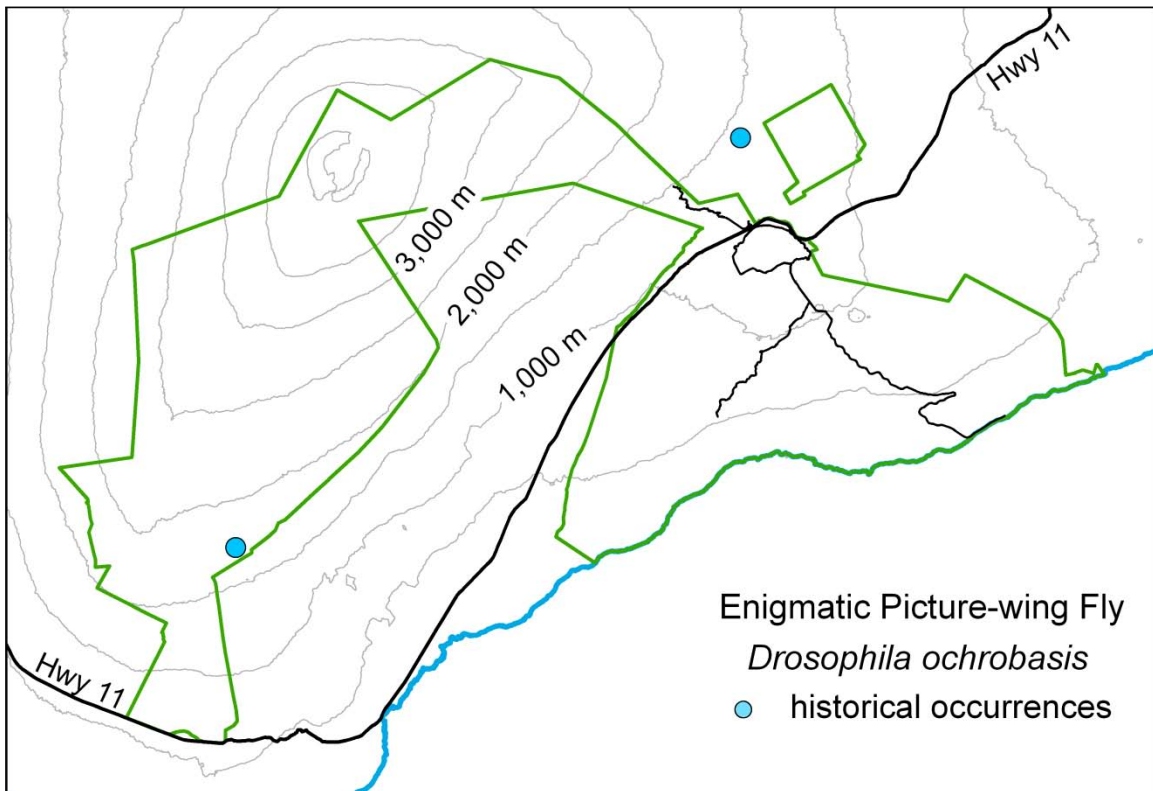
HABITS: Adults are always found in close association with native loulu palms, which is the likely host plant of the larvae.

SIMILAR SPECIES: No other species of Hawaiian picture-wing fly has been found on native loulu palms.

THREATS: The loulu palm, host plant of **Mull's picture-wing fly**, suffers from extensive seed depredation in montane wet forests. Little natural recruitment is evident under mature palms, except where feral pigs have been removed. The abundance of rat-gnawed seed hulls suggests that rats are a primary culprit in pig-free areas.

MANAGEMENT/RESTORATION STRATEGIES: **Mull's picture-wing fly** is protected under the Endangered Species Act. This picture-wing fly may benefit from rare plant restoration programs targeting native loulu palms and employing suppression of feral pig and rat populations.

REMARKS: This species is one of the most recently described of the Hawaiian picture-wing *Drosophila* fauna and is named in honor of Mr. William Mull of Volcano, who discovered it (Perreira and Kaneshiro 1990).



Enigmatic picture-wing fly, *Drosophila ochrobasis*
Photo: Karl Magnacca, University of Hawai`i at Hilo

COMMON NAME: **Enigmatic picture-wing fly**

SCIENTIFIC NAME: *Drosophila ochrobasis*

FAMILY: Drosophilidae (Pomace Flies)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered, listed in 2006

DESCRIPTION: The enigmatic picture-wing fly is 5 mm long and pale brown with dark brown or black markings over its body and wings. The wings are heavily mottled with dark markings, yielding an intricate pattern of light and dark spots. Males and females are sexually dimorphic in their wing patterns, with males having more light spots and females more dark ones (Hardy and Kaneshiro 1968).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: The enigmatic picture-wing fly is restricted to the island of Hawai`i, where it is found from the north end to the south but is rarely observed. It has been recorded **on Kohala Mountain south to Ka`ū District.**

HAVO DISTRIBUTION: Surprisingly, there is only a single known record of this species from HAVO. This **record is from Kahuku Unit (formerly Kahuku Ranch) near the boundary with the Ka`ū Forest Reserve.** This picture-wing fly may have once been common in the region. Additional populations are known from **areas adjacent to `Ōla`a Forest.**

HABITAT: Moist to wet montane forests from 1,000–1,800 m (3,280–5,905 ft) elevation.

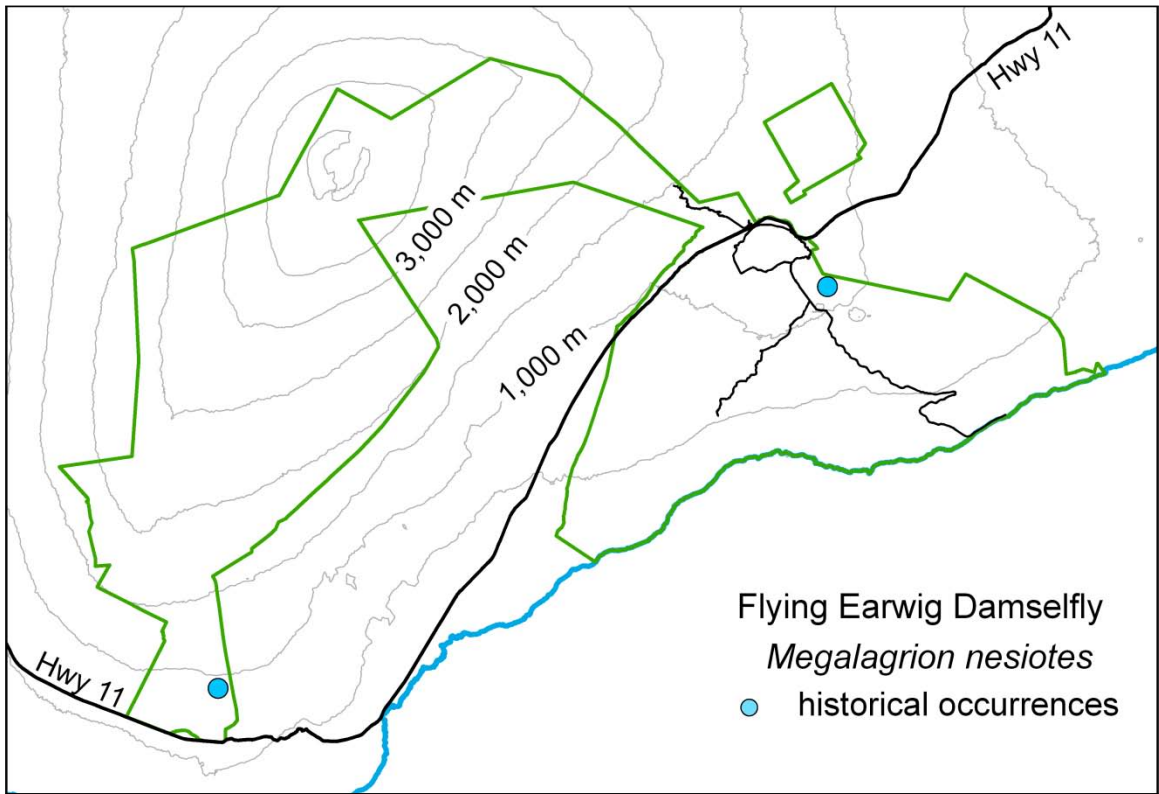
HABITS: Adults of the enigmatic picture-wing fly have been reared from a variety of native plants, including pala fern, `ōhā, and kōlea lau nui.

SIMILAR SPECIES: *Drosophila setosimentum* is very closely related, and the sexes have similar male and female patterns of spotting on the wings. The males can be distinguished only by the trained eye, and the females are indistinguishable. Naturally occurring hybrids between *D. setosimentum* and *D. ochrobasis* have been recorded.

THREATS: Cattle, feral pigs, and mouflon sheep have probably greatly contributed to the decline of important host plants for this picture-wing fly. Its scarcity may also be related to the introduction of the western yellowjacket wasp in the late 1970s (Foote and Carson 1995).

MANAGEMENT/RESTORATION STRATEGIES: The enigmatic picture-wing fly is protected under the Endangered Species Act, and critical habitat for this species is currently under review. This species will probably benefit from wasp and ungulate control programs coupled with host plant restoration. Augmentation of two **species of `ōhā and other native trees has already begun in experimental exclosures at Kahuku Unit (McDaniel *et al.* 2008).**

REMARKS: This picture-wing is unusual in that it has been recorded from a wide range of host plants but never consistently found on any one host across its range. **It is named "enigmatic" because of its puzzling distribution.**



Flying earwig damselfly, *Megalagrion nesiotae*
Photo: David J. Preston, Hawai'i Biological Survey, Bishop Museum

COMMON NAME: **Flying earwig damselfly**

SCIENTIFIC NAME: *Megalagrion nesiotes*

FAMILY: Coenagrionidae (Pond Damselflies)

SYNONYMS: None

FEDERAL AND STATE STATUS: Proposed Endangered Species in 2008

DESCRIPTION: Males of this endemic Hawaiian damselfly are up to 5 cm long and usually have a silvery blue-grey color (the silvery sheen is caused by "pruinosity," a waxy substance that covers the body of the damselfly and reflects the light). Under poor light conditions in the understory of fern forests where this damselfly resides, it appears drab and is very difficult to see. Females are more brownish, lack pruinosity, and are more rarely seen. The flying earwig damselfly derives its name from the relatively **long terminal appendages on the terminal end of the male's abdomen, but their size and shape is not** apparent without holding the insect under a magnifying glass. The larvae and breeding habitat of this species have never been described (Polhemus and Asquith 1996).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: This poorly known damselfly has been recorded on Maui and the island of Hawai'i in montane wet forests. The last observations came from East Maui in 2005.

HAVO DISTRIBUTION: In the late 19th century, the flying earwig damselfly was observed from Ha'ao Springs in Ka'ū Forest Reserve just below the southeast boundary of Kahuku Unit to Kilauea and the region of HAVO in Puna District (Perkins 1899).

HABITAT: Currently known from streambanks in moist to wet montane forest from about 300 to 900 m (1,000–3,000 ft) elevation on Maui. Most recent observations come from dense banks of uluhe fern mats. The damselfly's habits suggest that its immatures may inhabit damp fern litter, similar to a related species (O'ahu damselfly, *Megalagrion oahuense*) on the island of O'ahu.

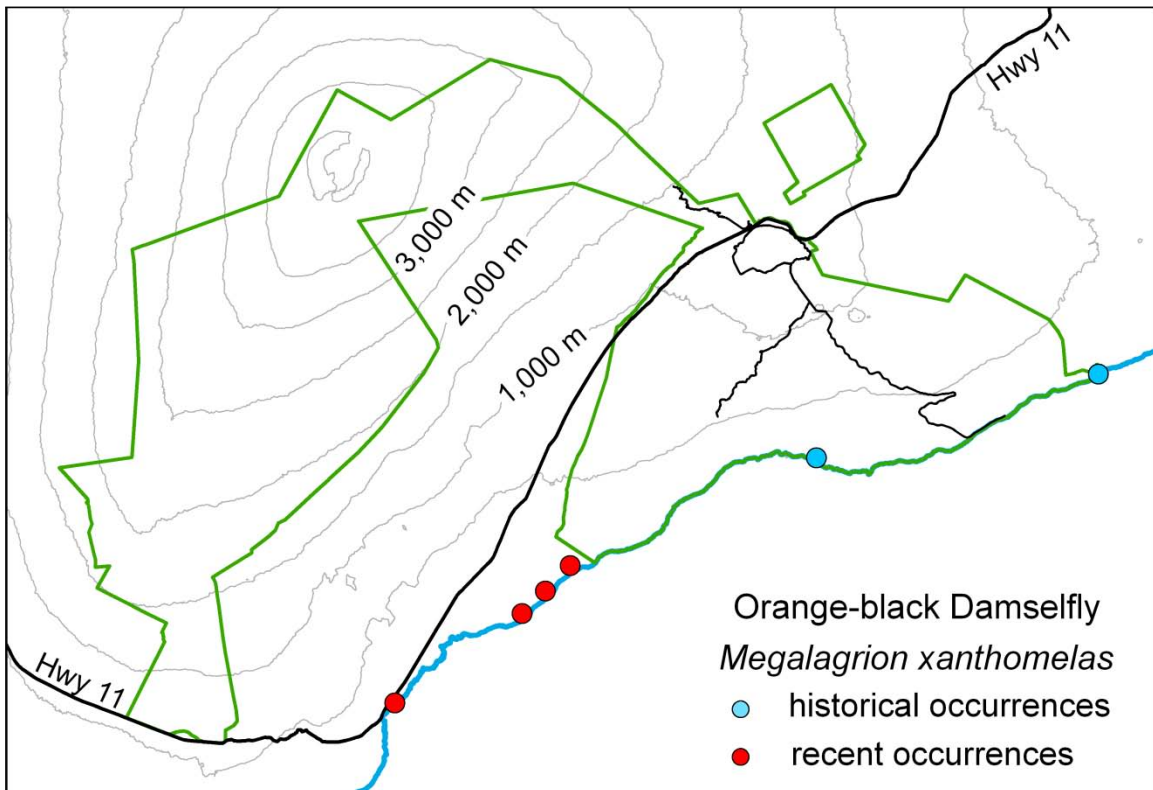
HABITS: Not studied.

SIMILAR SPECIES: The males of most Hawaiian damselflies are red, but the park's Koele Mountain damselfly (*Megalagrion koelense*), which breeds in the leaves of the native lily, pa`iniu, has a pruinose form that is sometimes confused with the flying earwig damselfly. However, the Koele Mountain damselfly in HAVO is smaller, rarely exceeding 4 cm in body length.

THREATS: The last known habitat of this rare damselfly is below major stream diversions in East Maui. There is evidence of long-term decline in stream flow in this region, and the combination of drought and stream diversions over the last decade may have led to this species' extinction. More recently, the uluhe fern banks formerly occupied by this damselfly have become overtopped by Koster's curse, an invasive weedy shrub.

MANAGEMENT/RESTORATION STRATEGIES: The flying earwig damselfly deserves intense targeted surveys in suitable habitat in HAVO and on Maui. If populations are rediscovered, every effort should be made to determine the breeding sites of this species and its habitat requirements. At this point, the species may be too rare to establish more than general restoration goals associated with maintaining historical stream flow and invasive weed control in areas where it was known to occur.

REMARKS: The 19th century British naturalist, R. C. L. Perkins, reported that the flying earwig damselfly was once widespread in the region that now includes Hawai'i Volcanoes National Park (Perkins 1899).



Orange-black damselfly, *Megalagrion xanthomelas*
Photo: David J. Preston, Hawai'i Biological Survey, Bishop Museum

COMMON NAME: **Orange-black damselfly**

SCIENTIFIC NAME: *Megalagrion xanthomelas*

FAMILY: Coenagrionidae (Pond Damselflies)

SYNONYMS: None

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: Males of this species are brightly colored reddish-orange, while females are dull greenish-grey and cryptic. The orange-black damselfly measures 35 mm long.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: The orange-black damselfly was historically found on all the major Hawaiian Islands, except Kaua`i (Polhemus and Asquith 1996).

HAVO DISTRIBUTION: **Orange-black damselflies are most abundant in the Ka`ū District adjacent to the park. Within HAVO, there has been a recent sighting from Halapē, and this damselfly historically occurred near the Waha`ula Visitor's Center in the Kalapana District, a site now destroyed by lava.**

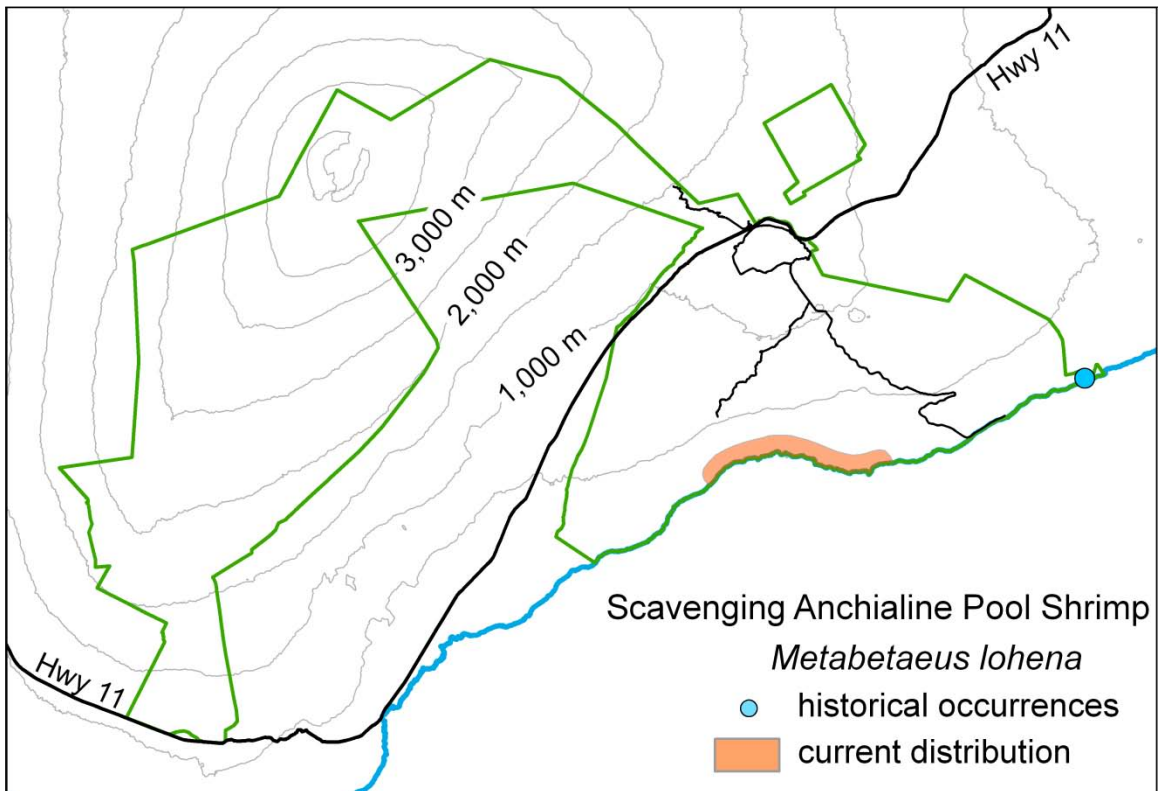
HABITAT: This Hawaiian damselfly is most likely seen near the coast in brackish water pools (anchialine pools exhibiting tidal fluctuations, but without any surface connection to the ocean) and other aquatic habitat, usually in association with vegetation.

HABITS: Males are most often seen perched on emergent vegetation or overhanging branches above pools of water. Following mating, the male holds on to the female using specialized terminal appendages on the tip of his abdomen. Pairs of mated damselflies will fly in tandem for hours while the female inserts her eggs into submerged vegetation or decaying leaves. Females are most often seen in tandem **with males. Larval damselflies are called "naiads" and feed on other aquatic insect larvae, especially** fly larvae such as mosquitoes. Upon completing their development, naiads crawl up on to exposed rocks or vegetation, and adult winged damselflies emerge leaving behind the exoskeleton, or larval skin, called an **"exuva."** **The exuvae persist a long time and are** the best evidence that damselflies inhabit a given pool.

SIMILAR SPECIES: Other native Hawaiian damselflies usually have red males and dull-colored females, but only the orange-black damselfly has been recorded from anchialine pools. Adult male Hawaiian damselfly species are distinguished primarily by differences in the shape and relative length of their two **sets of terminal appendages. These are "pincers" used to grasp specialized plates on the backs of** females of the same species, like a key and lock. Orange-black damselfly males are distinguished from most other Hawaiian damselflies by having lower (inferior) terminal appendages that are longer than the upper (superior) appendages.

THREATS: **In Hawai`i's national parks, alien ants and spiders are both** known to prey on adult damselflies, especially soon after they emerge from pools when they are unable to fly. Naiads are preyed upon by introduced guppies, including mosquitofish.

MANAGEMENT/RESTORATION STRATEGIES: Removal of alien fish from aquatic habitat and maintenance of aquatic vegetation promotes native damselflies. Orange-black damselfly naiads appear to coexist with fish in pools with native floating green algal mats where the larvae can avoid predation.



Scavenging anchialine pool shrimp, *Metabetaeus lohena*
Photos: © Mike Yamamoto

COMMON NAME: **Scavenging anchialine pool shrimp**

SCIENTIFIC NAME: *Metabetaeus lohena*

FAMILY: Alphaeidae (Snapping Shrimp)

SYNONYMS: none

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: This small shrimp measures only 12 mm long. Adults vary from almost white to dark red in color and possess pincers (called chelae) on their front legs.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Widespread and observable in suitable brackish water habitat such as anchialine pools (exposures of groundwater that exhibit tidal fluctuations but have no surface connection to the ocean) on the main Hawaiian Islands.

HAVO DISTRIBUTION: The scavenging anchialine pool shrimp has been recorded from coastal lava cracks at Ka`aha to vegetated anchialine pools at `Āpua Point and, historically, a cave located near the Waha`ula visitor's center (now covered by flows from Pu`u `Ō`ō) (Chai *et al.* 1989).

HABITAT: The scavenging anchialine pool shrimp appears to be adapted to complete its life cycle in brackish water habitat (groundwater with measureable salt concentrations from mixing with seawater). The shrimp do not survive well in freshwater or seawater alone. This species is most often seen in anchialine pools along the coast. It has rapidly colonized newly created pools including a large bomb crater on the island of Kaho`olawe. These observations suggest that this species occupies subterranean groundwater habitat in addition to exposed pools.

HABITS: These shrimp have been observed consuming other anchialine pool crustaceans, such as the **red shrimp `ōpae `ula (Maciolek and Brock 1974)**, and they also feed generally on arthropod remains (insects and spiders). Breeding (gravid) females carry many small dark eggs on the underside of their abdomens. While half of a given pool population may be egg-bearing, immature stages of this species have never been described.

SIMILAR SPECIES: This shrimp is frequently found in association with a smaller algal grazing shrimp, the `ōpae `ula (Hawaiian for red shrimp), *Halocaradina rubra*. The `ōpae `ula lacks pincers on its front legs and, instead, has small tufts of bristles that it uses to brush blue-green algal crusts and gather food particles.

THREATS: Coastal resort development has reduced the number of anchialine pools along the Kona Coast of Hawai`i, and groundwater withdrawal to support the water needs of a growing human population may also reduce habitat quality of the remaining pools. The dumping of garbage and pollutants into pools is also an ongoing threat. In national parks where pools are protected from development, the greatest threat to anchialine pool shrimp is probably the past introduction of alien fish and invertebrates to the pools. Mosquitofish and other guppies (Poeciliidae) are known to prey on anchialine pool shrimp. In HAVO the alien Tahitian prawn occurs at high densities at Halapē (Chai *et al.* 1989) and may compete directly for food with native `ōpae, such as the scavenging anchialine pool shrimp.

MANAGEMENT/RESTORATION STRATEGIES: Removal of alien prawns and fish from anchialine pools will help protect populations of anchialine pool shrimp. The scavenging anchialine pool shrimp can be abundant in both vegetated and unvegetated pools, so vegetation removal is not indicated.

REMARKS: This species was first described from specimens collected in the Ka`ū district of Hawai`i Island near HAVO (Banner and Banner 1960). It has subsequently been documented from as far away as the Sinai Peninsula and the Red Sea. However, the species does not have a continuous distribution. Broad, disjunct, global distributions are characteristic of anchialine pool crustaceans throughout the world.

Table 5. Endangered, Threatened, and Rare Plant Species of Hawai`i Volcanoes National Park

Common Name (Family)	Scientific Name	Status*
Ferns		
Island Peruvian spleenwort (Aspleniaceae)	<i>Asplenium peruvianum</i> var. <i>insulare</i>	E
Cut-leaved spleenwort (Aspleniaceae)	<i>Asplenium schizophyllum</i>	SOC
Palai lā`au (Grammitidaceae)	<i>Adenophorus periens</i>	E
Flowering Plants - Dicots		
Snakeroot (Apiaceae)	<i>Sanicula sandwicensis</i>	SOC
Hawaiian scaly-seed (Apiaceae)	<i>Spermolepis hawaiiensis</i>	E
Hōlei, Haleakalā hōlei (Apocynaceae)	<i>Ochrosia haleakalae</i>	C**
Hōlei, Kīlauea hōlei (Apocynaceae)	<i>Ochrosia kilaueaensis</i>	E, Ex?
`Ohe`ohe (Araliaceae)	<i>Polyscias kawaiensis</i>	NS, SOC
`Ohe makai, `Ohe, `Oheokai (Araliaceae)	<i>Polyscias sandwicensis</i>	SOC
`Āhinahina, Ka`ū silversword (Asteraceae)	<i>Argyroxiphium kauense</i>	E
`Āhinahina, Haleakalā silversword (Asteraceae)	<i>Argyroxiphium sandwicense</i> subsp. <i>macrocephalum</i>	T**
`Āhinahina, Mauna Kea silversword (Asteraceae)	<i>Argyroxiphium sandwicense</i> subsp. <i>sandwicense</i>	E**
Ko`oko`olau, Hawai`i ko`oko`olau (Asteraceae)	<i>Bidens hawaiiensis</i>	NS, SOC
`Ōhā, Lindsey's `ōhā (Campanulaceae)	<i>Clermontia lindseyana</i>	E
`Ōhā, Pele's `ōhā (Campanulaceae)	<i>Clermontia peleana</i> subsp. <i>peleana</i>	E
Hāhā, Shipman's hāhā (Campanulaceae)	<i>Cyanea shipmanii</i>	E
Hāhā (Campanulaceae)	<i>Cyanea stictophylla</i>	E
`Akū (Campanulaceae)	<i>Cyanea tritomantha</i>	C
Koli`i, Wimmer's koli`i (Campanulaceae)	<i>Trematolobelia wimmeri</i>	SOC
Pua pilo, Maiapilo (Capparaceae)	<i>Capparis sandwichiana</i>	SOC
Macrae's spreading schiedea (Caryophyllaceae)	<i>Schiedea diffusa</i> subsp. <i>macraei</i>	SOC
Hawaiian catchfly (Caryophyllaceae)	<i>Silene hawaiiensis</i>	T
`Ānunu, White `ānunu (Cucurbitaceae)	<i>Sicyos alba</i>	E
`Ānunu, Large-leaved `ānunu (Cucurbitaceae)	<i>Sicyos macrophyllus</i>	C
Uhiuhi (Fabaceae)	<i>Caesalpinia kawaiensis</i>	E**
Wiliwili (Fabaceae)	<i>Erythrina sandwicensis</i>	SOC, NS
`Ōhai (Fabaceae)	<i>Sesbania tomentosa</i>	E
Ha`iwale, Kanawao ke`oke`o, Giffard's ha`iwale (Gesneriaceae)	<i>Cyrtandra giffardii</i>	E
Ha`iwale, Kanawao ke`oke`o, Menzies' ha`iwale (Gesneriaceae)	<i>Cyrtandra menziesii</i>	SOC
Ha`iwale, Kanawao ke`oke`o, Bell ha`iwale (Gesneriaceae)	<i>Cyrtandra tintinnabula</i>	E
Huahekili uka, Kīlauea naupaka (Goodeniaceae)	<i>Scaevola kilaueae</i>	SOC
Ambiguous Hawaiian mint (Lamiaceae)	<i>Phyllostegia ambigua</i>	SOC, NS
Many-flowered Hawaiian mint (Lamiaceae)	<i>Phyllostegia floribunda</i>	C
Large-leaved Hawaiian mint (Lamiaceae)	<i>Phyllostegia macrophylla</i>	SOC, NS
Stachys-like Hawaiian mint (Lamiaceae)	<i>Phyllostegia stachyoides</i>	SOC

*E=Endangered, Ex?=Possibly Extinct, T=Threatened, C=Candidate Endangered, SOC=Species of Concern, NS=No current status. Status is both federal and State of Hawai`i except for the SOC category. NS, SOC species are officially recognized by the state but have no status in the federal list. SOC, NS species appear on the federal list but **not the state's list.**

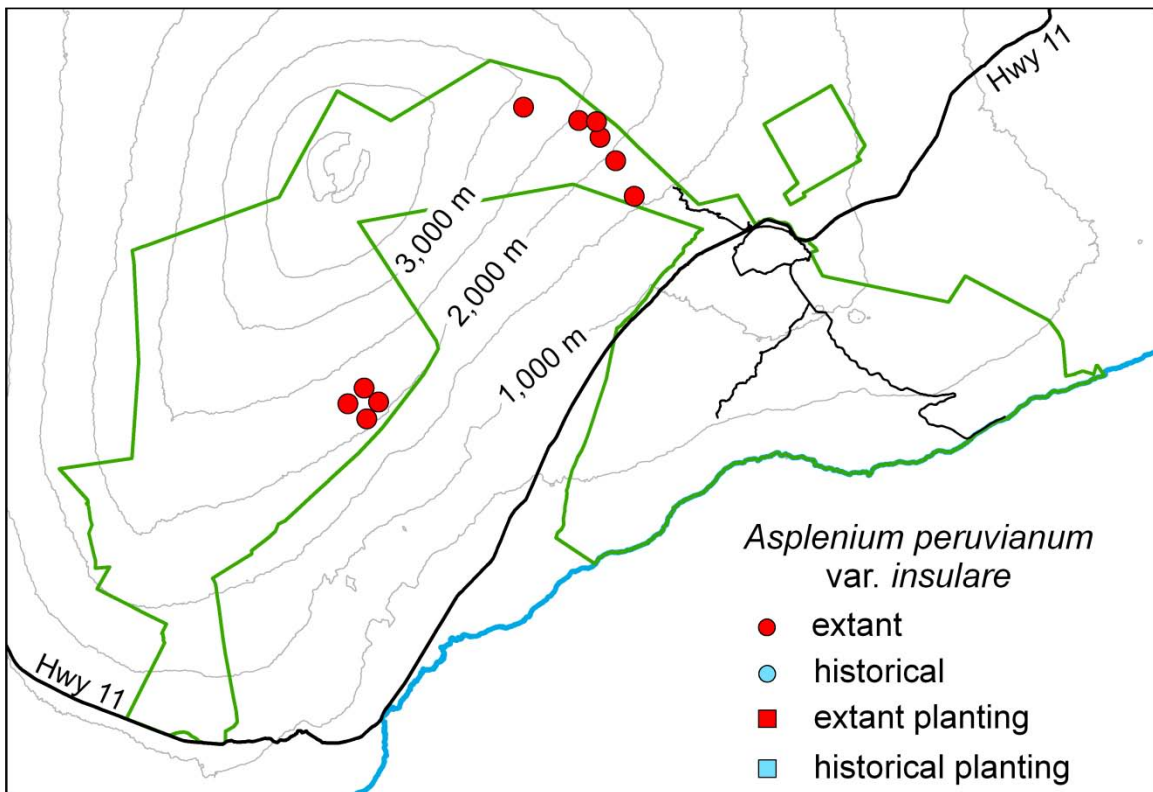
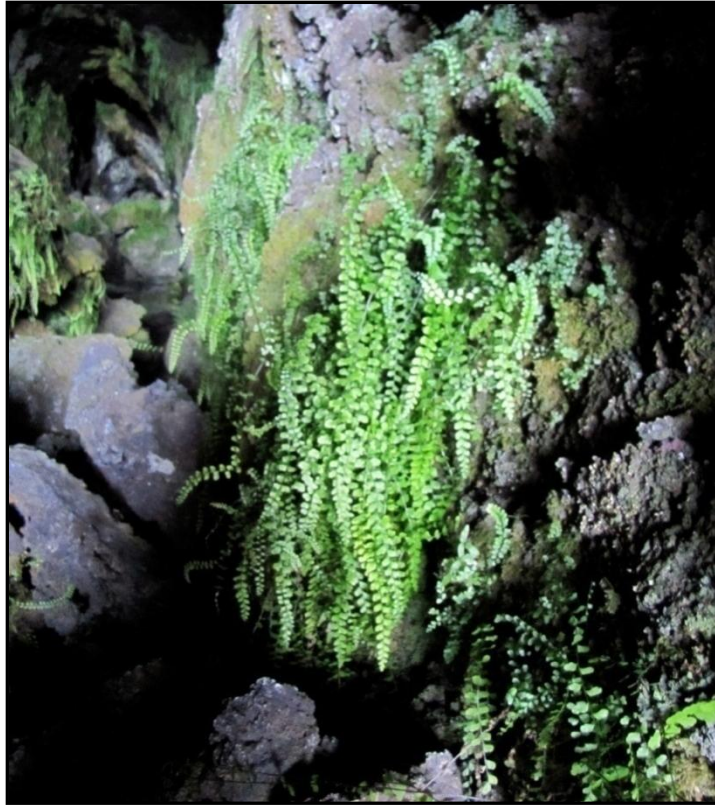
**Introduced to HAVO, but species not naturally occurring in the park.

Table 5. Endangered, Threatened, and Rare Plant Species of Hawai'i Volcanoes National Park (Continued)

Common Name (Family)	Scientific Name	Status*
Flowering Plants - Dicots (continued)		
Velvety Hawaiian mint (Lamiaceae)	<i>Phyllostegia velutina</i>	E
Clothed Hawaiian mint (Lamiaceae)	<i>Phyllostegia vestita</i>	NS, SOC
Narrow-leaved Hawaiian mint (Lamiaceae)	<i>Stenogyne angustifolia</i>	E
Large-flowered Hawaiian mint (Lamiaceae)	<i>Stenogyne macrantha</i>	SOC
Mōhihi (Lamiaceae)	<i>Stenogyne scrophularioides</i>	NS, SOC
Hau kuahiwi (Malvaceae)	<i>Hibiscadelphus giffardianus</i>	E
Ma`o hau hele (Malvaceae)	<i>Hibiscus brackenridgei</i> subsp. <i>brackenridgei</i>	E**
Koki`o, Hau hele`ula (Malvaceae)	<i>Kokia drynarioides</i>	E**
Kilioe (Myrsinaceae)	<i>Embelia pacifica</i>	NS
Popolo kū mai (Phytolaccaceae)	<i>Phytolacca sandwicensis</i>	NS, SOC
Hō`awa, Hawai`i hō`awa (Pittosporaceae)	<i>Pittosporum hawaiiense</i>	SOC
Laukāhi kuahiwi (Plantaginaceae)	<i>Plantago hawaiiensis</i>	E
`Ihi mākole, Po`e (Portulacaceae)	<i>Portulaca sclerocarpa</i>	E
`Ihi (Portulacaceae)	<i>Portulaca villosa</i>	SOC, NS
Makou, Hawai`i makou (Ranunculaceae)	<i>Ranunculus hawaiiensis</i>	C
Kauila (Rhamnaceae)	<i>Alphitonia ponderosa</i>	SOC, NS
`Ōhelo papa, Hawaiian strawberry (Rosaceae)	<i>Fragaria chiloensis</i> subsp. <i>sandwicensis</i>	SOC, NS
`Ākala, Macrae's raspberry (Rosaceae)	<i>Rubus macraei</i>	SOC
`Ahakea (Rubiaceae)	<i>Bobea timonioides</i>	SOC
Manena, Mokihana kūkae moa (Rutaceae)	<i>Melicope hawaiiensis</i>	SOC
Alani, Zahlbruckner's alani (Rutaceae)	<i>Melicope zahlbruckneri</i>	E
Kāwa`u (Rutaceae)	<i>Zanthoxylum dipetalum</i> var. <i>dipetalum</i>	SOC
A`e, Hawai`i a`e (Rutaceae)	<i>Zanthoxylum hawaiiense</i>	E
A`e, Kaua a`e (Rutaceae)	<i>Zanthoxylum kauaense</i>	SOC, NS
Hulumoa, Heau (Santalaceae)	<i>Exocarpos gaudichaudii</i>	SOC
`Aiea, Short-flowered `aiea (Solanaceae)	<i>Nothocestrum breviflorum</i>	E
Ānini (Theaceae)	<i>Eurya sandwicensis</i>	SOC
Ovate ma`aloa (Urticaceae)	<i>Neraudia ovata</i>	E
Flowering Plants - Monocots		
Hala pepe (Agavaceae)	<i>Pleomele hawaiiensis</i>	E
Loulu (Arecaceae)	<i>Pritchardia affinis</i>	E
Loulu (Arecaceae)	<i>Pritchardia beccariana</i>	SOC
Hawaiian fringed sedge (Cyperaceae)	<i>Fimbristylis hawaiiensis</i>	SOC
Mau`u lā`ili (Iridaceae)	<i>Sisyrinchium acre</i>	SOC, NS
`Ohe (Joinvilleaceae)	<i>Joinvillea ascendens</i> subsp. <i>ascendens</i>	C
Honohono, Jewel orchid (Orchidaceae)	<i>Anoectochilus sandwicensis</i>	SOC
`Awapuhi a Kanaloa, Twayblade (Orchidaceae)	<i>Liparis hawaiiensis</i>	SOC
Hilo ischaemum (Poaceae)	<i>Ischaemum byrone</i>	E

*E=Endangered, Ex?=Possibly Extinct, T=Threatened, C=Candidate Endangered, SOC=Species of Concern, NS=No current status. Status is both federal and State of Hawai`i except for the SOC category. NS, SOC species are officially recognized by the state but have no status in the federal list. SOC, NS species appear on the federal list but **not the state's list.**

**Introduced to HAVO, but species not naturally occurring in the park.



Island Peruvian spleenwort, *Asplenium peruvianum* var. *insulare*
 Photo: Thomas Belfield PCSU/NPS, HAVO

COMMON NAME: **Island Peruvian spleenwort**

SCIENTIFIC NAME: *Asplenium peruvianum* var. *insulare*

FAMILY: Aspleniaceae (Spleenwort Family)

SYNONYMS: *Asplenium rhomboideum*, *Asplenium fragile* var. *insulare*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Small fern with a narrow linear frond blade, once pinnate, 15–46 cm long and 1–3 cm wide. Blade of frond pale to bright green; rachis and stipe dull gray or brown with two green lines or ridges on the upper surface. Pinnae small (<15 mm long), rhomboidal in shape, with 1–5 shallow lobes on the upper margin. Sori linear, <5 per pinna, with a thin indusium (Palmer 2003). Typically, this fern grows in moist lava tubes. Phenology: Often found in sterile condition.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Maui and Hawai`i Islands. Known from eight populations on Hawai`i Island, including HAVO; populations **near HAVO are Kūlani, Kapāpala, and Ka`ū Forest Reserves**. Historically collected on Mauna **Kea, Mauna Loa, Hualālai**, and near Hilo (U.S. Fish and Wildlife Service 1998b). Recently, *A. peruvianum* was found in South Kona District (K. Bio, pers. comm.).

HAVO DISTRIBUTION: The Mauna Loa Strip above 1,680 m (5,500 ft) elevation and Kahuku Unit above 1,840 m (6,030 ft) contain the only known populations of this fern in the park. One lava tube within the **Mauna Loa Strip at a kīpuka between Kīpuka Kulalio and Kīpuka Mauna`iu has supported a population of Island Peruvian spleenwort since 1943**. This spleenwort has been recently confirmed at five other Mauna Loa Strip lava tube skylights (L. Pratt, pers. obs.). At Kahuku, the fern was found at four subalpine sites **above Ka`ū Forest Reserve (Benitez et al. 2008)**. The recovery plan for the fern (U.S. Fish and Wildlife Service 1998b) showed an unlikely **occurrence above Hilina Pali in HAVO at "Kīpuka Ahiu."**

HABITAT: Within HAVO, Island Peruvian spleenwort is currently restricted to large-diameter, moist lava tubes at high elevation. It is possible that this fern is limited to lava tubes as a consequence of feral ungulate damage. The fern is typically found on tube walls and ceilings within the lighted zone near the opening, but a few individuals have been found in deep, dark recesses of lava tubes. Elsewhere the fern has been noted growing in lava cracks and on cliffs.

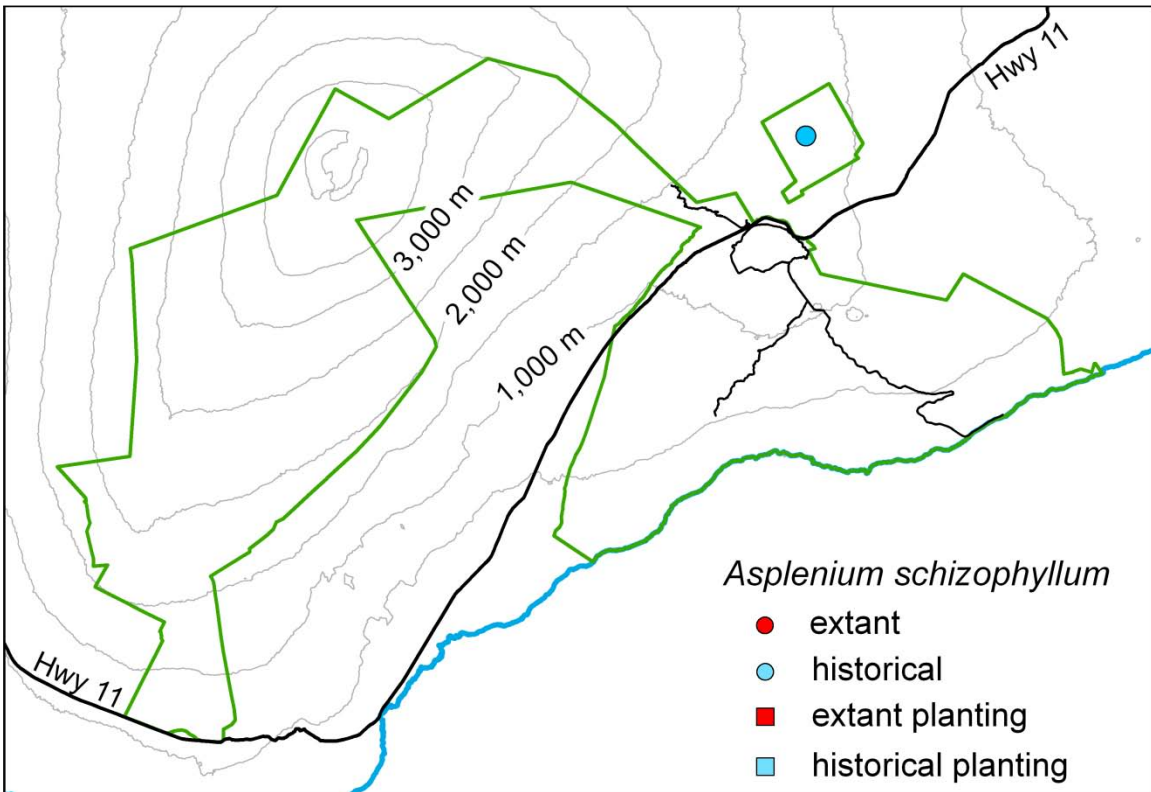
SIMILAR SPECIES: *Asplenium macraei*, `iwa`iwa lau li`i, was suggested as the most similar related species by the recovery plan (U.S. Fish and Wildlife Service 1998b). However, on Hawai`i Island the two ferns do not grow in the same areas, and the species most likely to be confused with *A. peruvianum* is *A. trichomanes* subsp. *densum* or `oāli`i. **Typical *A. trichomanes* differs markedly from *A. peruvianum*, because of its small, thick pinnae, shiny black stipe and rachis, and terrestrial growth habit. It also has eight lobes on its pinnae and more than five sori per pinna. When *A. trichomanes* grows in shady conditions, it is pale green and thin in texture. *Asplenium monanthes* or other once-pinnate species may also be confused with *A. peruvianum*.**

THREATS: Feral goats and mouflon sheep are potential threats, although the island Peruvian spleenwort seems able to persist in lava tubes. Invasive alien plant species that infest lava tube openings, such as common mullein, may be threats, but competition has not been studied.

MANAGEMENT/RESTORATION STRATEGIES: The habitat of this fern within HAVO is contained within Mauna Loa Special Ecological Area and Kahuku Unit. The lower unit of the SEA has been free of feral pigs and goats for almost two decades. Feral goats and mouflon sheep have been removed from the alpine unit, and sheep numbers are being reduced at Kahuku. The feasibility of common mullein control is being investigated (Loh et al. 2000). Propagation and restoration have not been attempted in HAVO.

REMARKS: This fern may be a naturally rare species confined to a limited specialized habitat.

CULTURAL USES/ETHNOBOTANY: None known.



Cut-leaved spleenwort, *Asplenium schizophyllum*

Photo: Thane Pratt USGS, PIERC; Herbarium sheet from HAVO Natural History Collection

COMMON NAME: **Cut-leaved spleenwort**

SCIENTIFIC NAME: *Asplenium schizophyllum*

FAMILY: Aspleniaceae (Spleenwort Family)

SYNONYMS: *Asplenium baldwinii*, *A. dissectum*, *A. dissectum* var. *kauaiense*, *A. nephelephyllum*

FEDERAL AND STATE STATUS: Species of Concern, former Candidate

DESCRIPTION: Fern, terrestrial or epiphytic. Fronds quadripinnate, deltate-lanceolate in shape, thick-textured, finely dissected with linear pinnules only 1–2 mm wide; pinnae more than 12 free pairs per frond, longest pinnae more than 30 mm long, lower pinnae not reduced in size. Stipe of frond dark brown and often smooth and hairless with dark brown to black scales only at the base. Sori linear with an indusium opening on one side (Hillebrand 1888, Palmer 2003). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to the Hawaiian Islands of Kaua`i and Hawai`i at 750–1,500 m elevation (2,460–4,920 ft) (Palmer 2003). **Recently observed on Hawai`i Island in Kīlauea Forest** (L. Pratt, pers. obs.) and Pu`u Maka`ala Natural Area Reserve (Palmer 2003).

HAVO DISTRIBUTION: The presence of this fern in HAVO is hypothetical. **Possibly occurs in `Ōla`a Forest**, but that record may be based on an error in identification. This species is listed as present within HAVO (Higashino *et al.* 1988), but no specimen from the park is deposited in the HAVO Herbarium.

HABITAT: Montane wet forest.

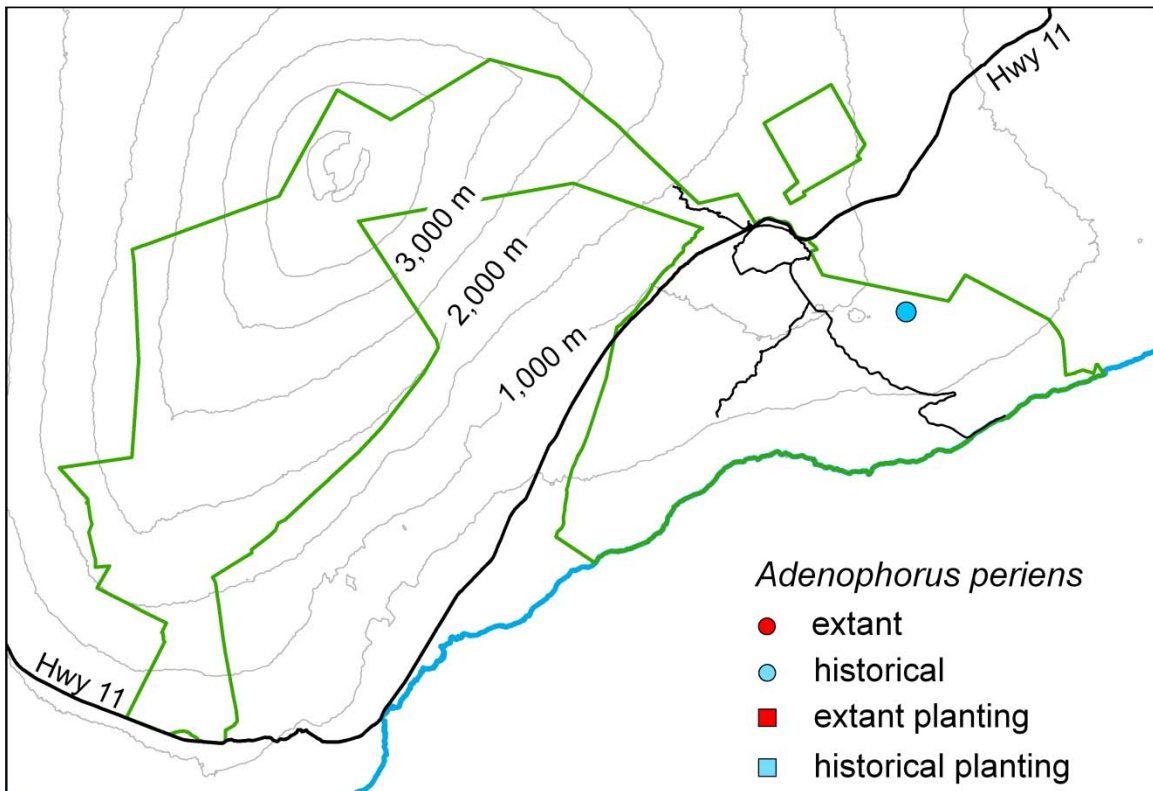
SIMILAR SPECIES: It is often difficult to determine species within the genus *Asplenium* with confidence. In the recent definitive work on Hawaiian ferns (Palmer 2003), *A. schizophyllum* was described as most closely related to the epiphytic *A. haleakalense*, restricted to East Maui. The most similar species to *Asplenium schizophyllum* in `Ōla`a is *A. sphenotomum*, relatively common on Hawai`i Island. However, the finely dissected fronds of *A. schizophyllum* are distinctive, and the rare fern is larger than *A. sphenotomum* and lacks any young plantlets at frond tips (and thus is not proliferous).

THREATS: Feral pigs are a threat to this fern, which may be terrestrial or epiphytic at the base of trees. Invasive alien plant species may displace rare epiphytes.

MANAGEMENT/RESTORATION STRATEGIES: **Five units of `Ōla`a Forest have been fenced, and feral pigs have been removed from all but the new unit. Invasive alien plants such as kāhili ginger, banana poka, strawberry guava, and yellow Himalayan blackberry are controlled in all or part of three units. Confirmation of the species' presence within HAVO by searching likely habitat would help guide** development of specific management strategies. Even if this spleenwort is not currently found in HAVO, the fern is an appropriate species for introduction or re-introduction to `Ōla`a Forest because of its presence in adjacent forests.

REMARKS: Cut-leaved spleenwort was listed as threatened to very rare by Wagner (1995), who suggested that the best way to save rare Hawaiian ferns is to determine their natural environment and protect those areas as preserves.

CULTURAL USES/ETHNOBOTANY: None known.



Palai lā`au, *Adenophorus periens*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Palai lā`au**

SCIENTIFIC NAME: *Adenophorus periens*

FAMILY: Grammitidaceae (Grammitis Family)

SYNONYMS: *Oligadenus periens*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Small to medium-sized, epiphytic fern. Fronds simple, deeply pinnatifid, 10 to >40 cm long, 1.3–2.2 cm wide, pendulous; typically yellow-green with twisted lobes; axes of frond lobes nearly perpendicular to frond midrib or rachis. Edge of frond ciliate with dark marginal hairs. Sori round, lacking an indusium, usually in two rows on frond lobes; lower part of frond most likely to be fertile (Bishop 1974, Palmer 2003). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Historically present on all main Hawaiian Islands, except Ni`ihau and Kaho`olawe. Currently restricted to Hawai`i, Moloka`i, and Kaua`i at 700–1,300 m elevation (2,300–4,260 ft) (Palmer 2003). The largest Hawai`i Island population is adjacent to HAVO in Kahauale`a Natural Area Reserve (NAR), where it was estimated that several hundred to several thousand plants persisted (Ranker 1994).

HAVO DISTRIBUTION: **Kāne Nui o Hamo in the East Rift Special Ecological Area (SEA);** this fern may also have occurred at other sites within the SEA. Possibly extirpated from HAVO.

HABITAT: **Open to closed lowland wet forest of `ōhi`a lehua with tree fern understory; stunted `ōhi`a forest of windswept ridges on older islands.** In HAVO, the fern is usually epiphytic on trunks of large `ōhi`a lehua trees.

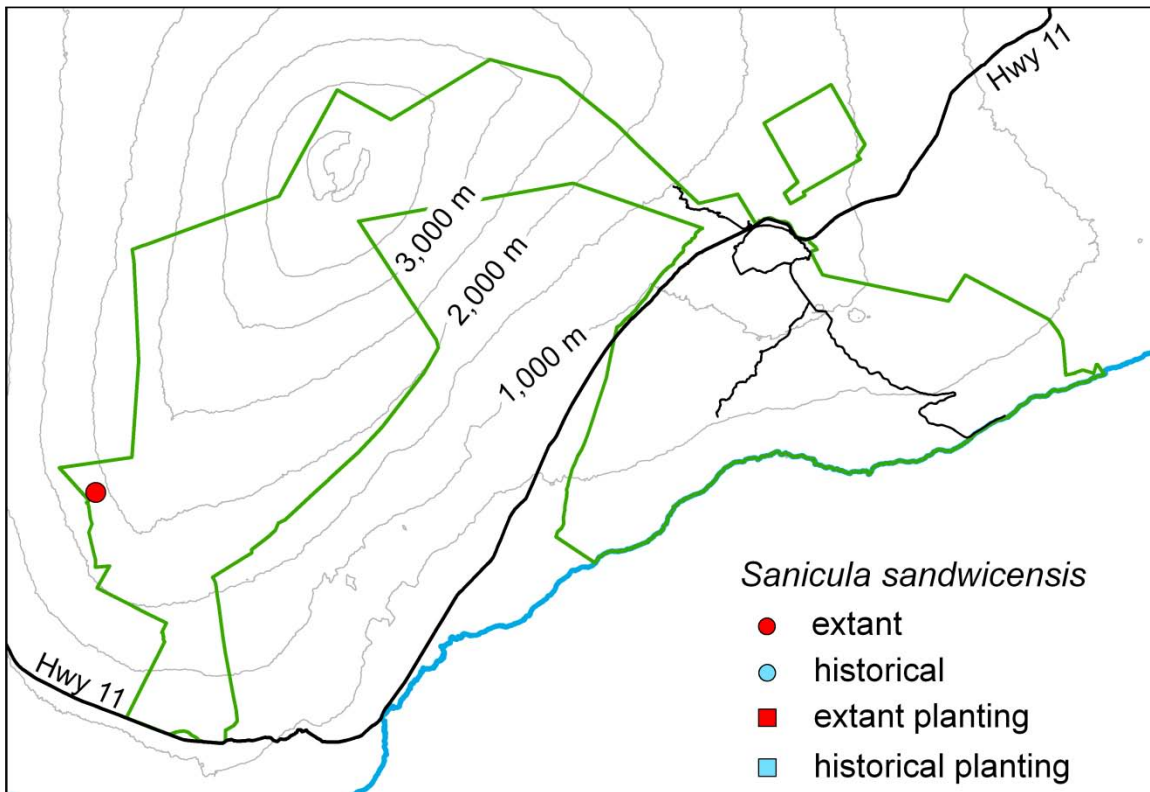
SIMILAR SPECIES: *Adenophorus pinnatifidus*, also a small epiphyte, most closely resembles *A. periens*, **palai lā`au.** Typically *A. pinnatifidus* is a smaller fern, and it does not have twisted lobes or marginal hairs on the frond. The angle of insertion of the lobes on the midrib is more acute than 90°, as is that of *A. periens*.

THREATS: Sulfur dioxide fumes and acid rain are natural threats to the fern during eruptions of Kīlauea. Prolonged drought may be a limiting factor. Feral pig activity may damage the understory of the forest habitat of the species and eventually lead to the loss of shady and cool **conditions necessary to the fern's survival.** **Habitat degradation by feral animals is listed as the primary threat to palai lā`au in the species' recovery plan (U.S. Fish and Wildlife Service 1999).**

MANAGEMENT/RESTORATION STRATEGIES: The habitat of palai lā`au at HAVO is within the East Rift SEA, which is fenced and free of feral pigs. The unit is monitored for occasional pig ingress. Alien plant control is planned for the SEA, targeting yellow Himalayan raspberry, faya, strawberry guava, and cane tibouchina. No plantings of this fern have been made; research into propagation methods may be required before restoration can be attempted. If propagation of the species were successful, the fern could be placed in **pig-free Kīlauea forests subject to less constant volcanic fumes.**

REMARKS: The species may have been lost from HAVO, as it has not been sighted within the park since the mid-1980s. **Sites on the eastern slope of Kāne Nui o Hamo, where palai lā`au formerly grew, have been repeatedly searched without finding the fern.** The species has apparently also declined within Kahauale`a NAR, but the population there remains the largest known in the Hawaiian Islands (U.S. Fish and Wildlife Service 1999). The minimum effective population size to maintain genetic variability of the species has been estimated at 7,000 to 70,000 (Ranker 1994).

CULTURAL USES/ETHNOBOTANY: None known.



Snakeroot, *Sanicula sandwicensis*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Snakeroot**

SCIENTIFIC NAME: *Sanicula sandwicensis*

FAMILY: Apiaceae (Parsley Family)

SYNONYMS: *Sanicula haleakalae*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Perennial herb with a large swollen root. Solitary stem branched above the base. Leaves of two kinds: basal and stem (cauline). Basal leaves rounded, 3–12 cm wide, three- to five-parted with deeply lobed segments and spiny-serrate margins. Basal leaf petioles 10–33 cm long, slender, sheathing at base. Stem leaves reduced at top of plant, palmately divided and lobed, with a slender petiole or sessile. Flowers in terminal inflorescences of umbels with 20 flowers per umbel, peduncles 1.5–4 cm long; flowers perfect and staminate (male); calyx with ovate teeth 1 mm long, petals yellow, style longer than calyx, recurved. Fruits are ovoid, about 4 mm long and 3 mm wide, covered with bulbous prickles (Wagner *et al.* 1999). Phenology: Unknown. At Kahuku plants bore the remains of flowers in the fall (HAVO Herbarium).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Haleakalā, East Maui, and Hawai`i between 2,000 and 2,600 m (6,500–8,500 ft) elevation. On Hawai`i Island, snakeroot is distributed on Mauna Kea, Mauna Loa, and Hualālai Volcanoes.

HAVO DISTRIBUTION: Currently known in the park from a single small population of less than 20 plants in the western section of Kahuku Unit.

HABITAT: Subalpine shrubland and woodland. In Kahuku Unit of HAVO, snakeroot is growing among **native shrubs in `ōhia lehua woodland on the edge of a subalpine kīpuka.**

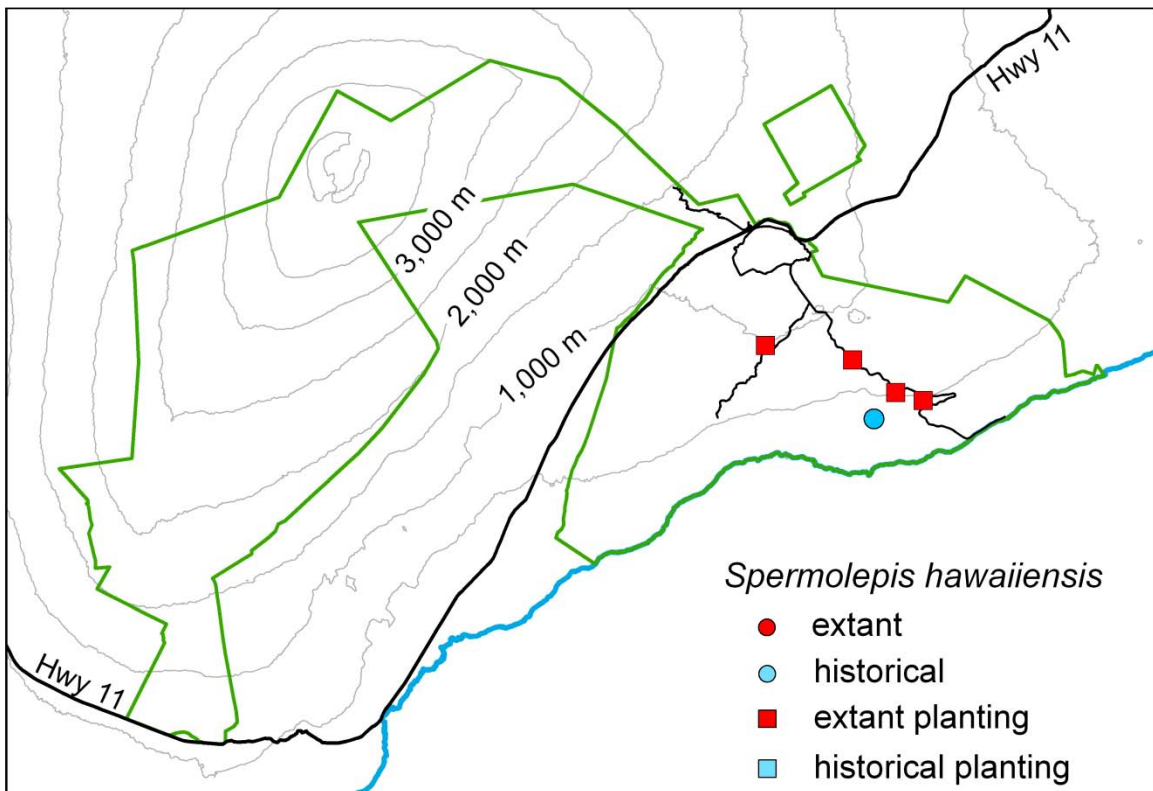
SIMILAR SPECIES: Superficially similar to native and alien species of buttercups (*Ranunculus*). The native *R. hawaiiensis* grows in the same habitat but has hairy stems and leaves and larger yellow flowers, which are not borne in umbels. Fruits of the two species are also very different; *Ranunculus hawaiiensis* fruits are achenes in a head, each with a curved beak, while *Sanicula sandwicensis* has dry, two-parted fruits, ovoid in shape, covered with stout, hooked prickles.

THREATS: Feral ungulates, particularly pigs and mouflon sheep, are likely the greatest threats to the species at Kahuku Unit. Feral pigs are known to uproot and eat snakeroot (T. Pratt, pers. obs.). Fire is a potential threat.

MANAGEMENT/RESTORATION STRATEGIES: This species will likely benefit from current efforts to reduce feral pig and mouflon sheep numbers at Kahuku Unit. No planting of snakeroot has been done at HAVO because little propagation material has been available, but many sites at Kahuku are suitable for restoration of this species. Fire is unlikely in the subalpine habitat of this species.

REMARKS: This species is a new addition to the flora of HAVO. Snakeroot was not known from the original section of the park, and it was only recently located at Kahuku Unit during a vascular plant inventory (Benitez *et al.* 2008).

CULTURAL USES/ETHNOBOTANY: Elsewhere in the world, members of this genus are used medicinally (Wagner *et al.* 1999), but the Hawaiian species is not listed among Hawaiian plants commonly used for medicine (McBride 1975, Krauss 2001).



Hawaiian scaly-seed, *Spermolepis hawaiiensis*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Hawaiian scaly-seed**

SCIENTIFIC NAME: *Spermolepis hawaiiensis*

FAMILY: Apiaceae (Parsley Family)

SYNONYMS: *Apium echinatum*, *Caucalis daucoides*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Annual herb, less than 20 cm tall. Leaves are three times compound, oblong to ovate, 1–4 cm long; ultimate divisions are linear, 3–6 mm long, with rough margins; basal petioles slender 2–3 cm long, tapering to a sheath. Flowers are borne in weak compound umbels with inflorescence stalks 1–3 cm long, subtended by a leaf-like bract; two to six unequal clusters of flowers per inflorescence, each 5–15 mm long with two to six flowers in ultimate clusters. Individual flowers lack sepals, but have five white petals, five stamens, and a short style with a swollen base. Fruits are small dry, dehiscent, two-parted schizocarps, ovoid, compressed laterally, 3–4 mm long and 2–4 mm wide, and covered with protuberances and bristles. Seeds are small and grooved (Wagner *et al.* 1999). Phenology: Unknown, but the plant is an annual, present only part of the year. It is likely that the Hawaiian scaly-seed flowers in the spring, based on old collections from HAVO (Fosberg 1966).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Kaua`i, O`ahu, Moloka`i, Maui, and Hawai`i; known from open areas in the lowland and montane zones, as well as from cultivated fields at low elevation. Recent observations **have been from dry lowland sites on O`ahu (Diamond Head), Moloka`i (Kamalō), Lanā`i (Ka`a Gulch and near Pu`u Manu), and West Maui (Līhau and Lahaina Luna). On Hawai`i Island, Hawaiian scaly-seed is extant at several sites in Pōhakuloa Training Area and Pu`u Anahulu (U.S. Fish and Wildlife Service 1999).**

HAVO DISTRIBUTION: Documented as naturally occurring at a single locality within HAVO in `Āpua land section at 610 m (2,000 ft) elevation (Fagerlund and Mitchell 1944). Since the 1940s, the area has been covered by lava flows and cinder from the Mauna Ulu eruption of 1969–74. Recently, Hawaiian scaly-seed was sowed **at Nāulu Forest, upper Kahue, Kīpuka Kahali`i, and along the Hilina Pali Road.**

HABITAT: In HAVO, Hawaiian scaly-seed occurred in low-elevation open `ōhi`a lehua forest.

SIMILAR SPECIES: *Spermolepis hawaiiensis* is an inconspicuous herb that resembles several related weedy species, such as fir-leaved celery (*Ciclospermum leptophyllum*), wild carrot (*Daucus pusillus*), and parsley (*Petroselinum crispum*). When not in flower, *Spermolepis* might also be confused with alien herbs of the Aster Family, possibly *Soliva sessilis*, false ragweed (*Parthenium hysterophorus*), and Australian brass buttons (*Cotula australis*).

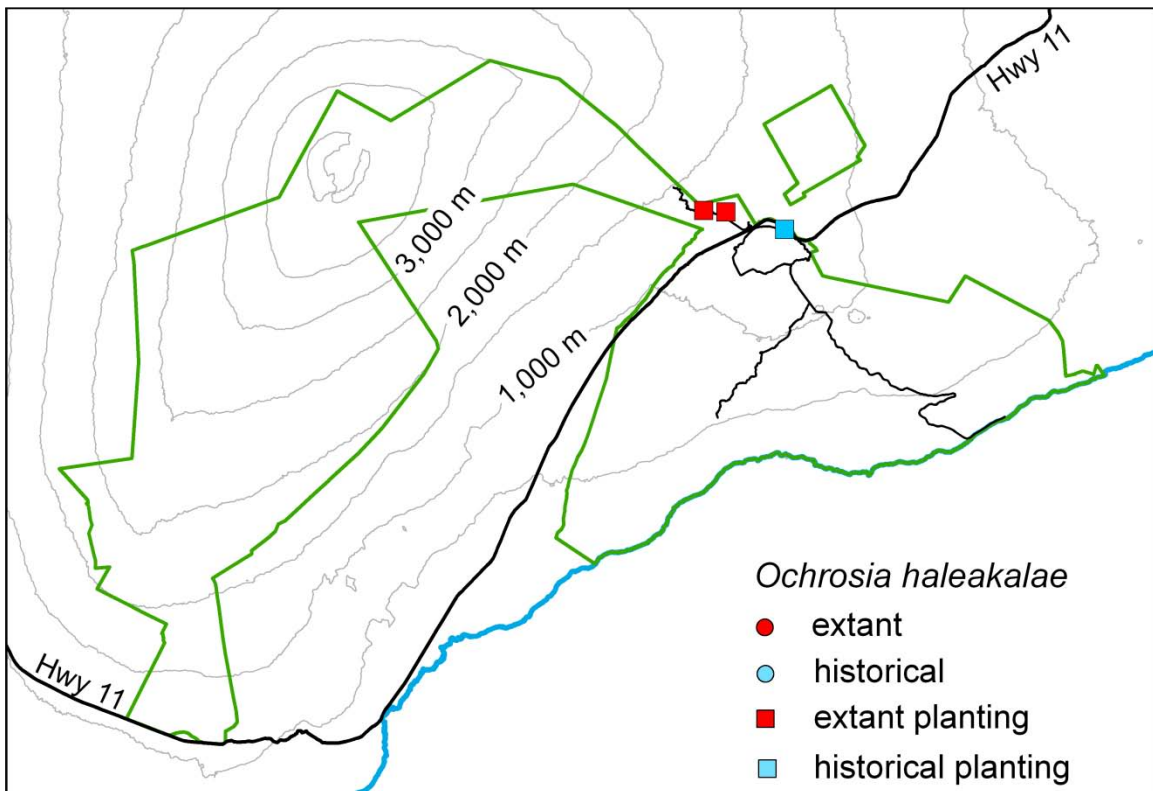
THREATS: Feral goats, axis deer, mouflon sheep, alien plants, fire, and landslides are listed as reasons for decline of this endangered species by the U.S. Fish and Wildlife Service (1999). In HAVO, feral goats may have contributed to the loss of the species, but natural lava flows and cinders probably covered most of its last known habitat.

MANAGEMENT/RESTORATION STRATEGIES: Lowland habitat for Hawaiian scaly-seed still exists in **Kīpuka Kahali`i Special Ecological Area** of HAVO, which is protected from feral animals, fire, and invasive alien trees. Recently (2006–2007) as part of a rare plant stabilization project, seeds from a remaining **population at Pōhakuloa were broadcast at Nāulu Forest, Kīpuka Kahali`i, a kīpuka in Kahue ahupua`a** on the Chain of Craters Road, and at a site along Hilina Pali Road. Seedlings were observed following sowing. However, monitoring did not confirm establishment of populations at the sowing sites (Belfield *et al.* 2011). It may be informative to re-visit seeded sites in the spring to search for this annual plant.

REMARKS: Additional efforts may be required to restore Hawaiian scaly-seed to HAVO.

CULTURAL USES/ETHNOBOTANY: None known.

Introduced to HAVO



Hōlei, Haleakalā hōlei, *Ochrosia haleakalae*
Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Hōlei, Haleakalā hōlei**

SCIENTIFIC NAME: *Ochrosia haleakalae*

FAMILY: Apocynaceae (Dogbane Family)

SYNONYMS: *Ochrosia hamakuaensis*

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: Small tree 2–8 m tall; bark smooth. Leaves three to four per node, elliptic to oblanceolate, 6–15 cm long and 2.5–4.5 cm wide, shiny dark green, with conspicuous lateral veins; petioles 0.8 to 2.5 cm long.; milky sap when foliage broken. Flowers are numerous in open, axillary inflorescences about 6 cm long; individual flowers have a calyx with five ovate lobes 3–4 mm long and a white, tubular corolla 10–11 mm long with five lobes 7–11 mm long, five stamens within the corolla tube, and a short style with a two-parted stigma. Flowers are fragrant when open. Fruits are large, two-parted drupes, 5–6 cm long and 3–3.5 cm wide, fleshy when young and hard when mature, dull yellow and ridged when ripe. One large, ovate seed, 25 mm long, is found within each fruit section (Wagner *et al.* 1999). Phenology: Flowers in summer.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: East Maui and windward Hawai`i Island at elevations between 700 and 1,200 m (2,300–3,940 ft); not native to HAVO.

HAVO DISTRIBUTION: Planted and naturalized at Kīpuka Puauulu and Kīpuka Kī. Trees were planted in 1954–55 (Morris 1967), in the 1970s (N. Zimmer, unpublished data), and in 2006 (Belfield *et al.* 2011). Original seed sources were natural trees at Auwahi, Maui. Formerly planted near HAVO headquarters.

HABITAT: Lowland or montane dry to mesic forest and lava fields on Maui; lowland wet forest on windward Hawai`i. In HAVO, this hōlei was **planted in montane mesic forest of koa, `ōhi`a, and mānele.**

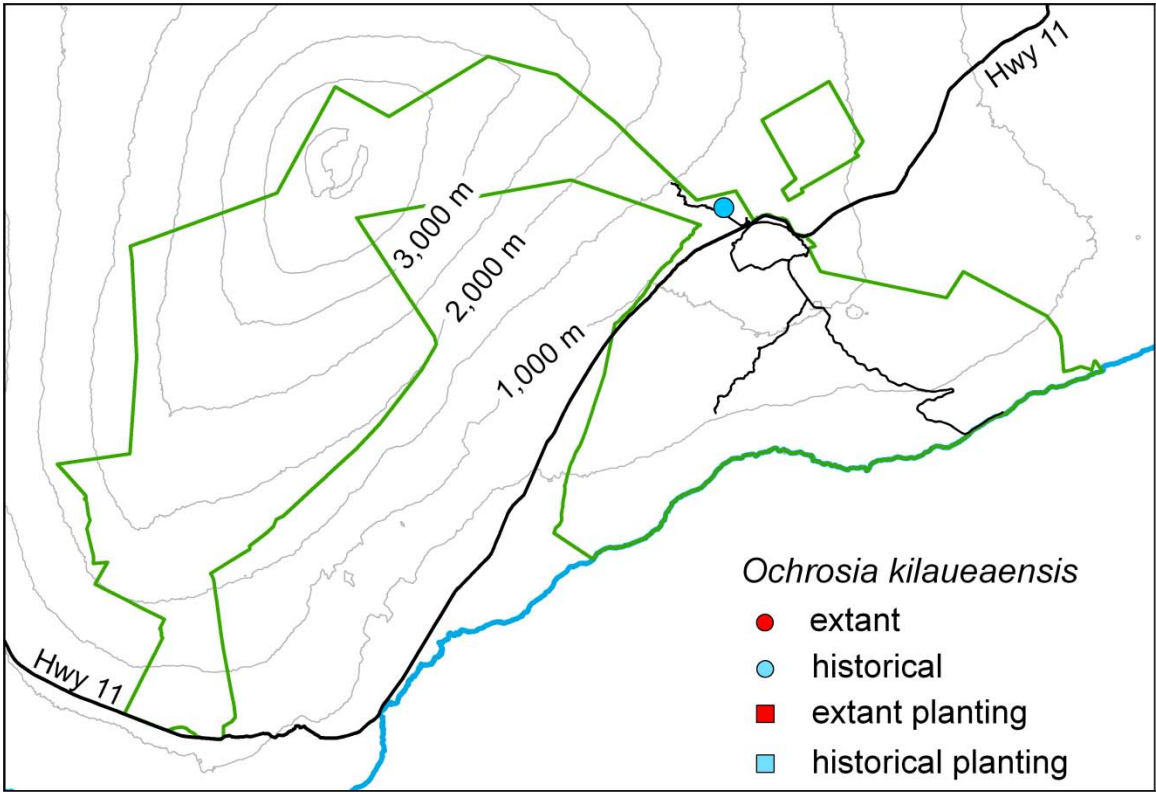
SIMILAR SPECIES: Other hōlei species are very similar in appearance, differing primarily in floral characters. *Ochrosia kilaueaensis* has a flower calyx 10–11 mm long, almost three times longer than that of *O. haleakalae*. Its inflorescence is also more open, and its flower stalks (5–7 mm long) are twice as long as those of *O. haleakalae* (Wagner *et al.* 1999).

THREATS: Feral pigs are a threat in wet forests; feral goats and domestic cattle, alien grasses, and wildfire are threats to the dry and mesic forest **habitat of the species. Most natural habitat of hōlei has been converted into cattle ranches.**

MANAGEMENT/RESTORATION STRATEGIES: Haleakalā hōlei grows within HAVO because of past management activities. The introduction was made when trees of Maui and Kīpuka Puauulu were thought to be the same species (Rock 1913). In 1954–55, **more than 20 hōlei trees were planted in Kīpuka Puauulu, Kīpuka Kī, and near park headquarters** (Morris 1967). Then in 1974–80, **>180 hōlei** were planted in Kīpuka Puauulu using local seeds, and >60 survived until 1981 (N. Zimmer, unpublished data). In a rare plant survey in 1993 (L. Pratt and L. Abbott, unpublished data) **136 hōlei** were mapped in the kīpuka. Large trees were reproducing and recruiting seedlings and saplings. Both Kīpuka Puauulu and Kīpuka Kī are Special Ecological Areas. Cattle, feral goats, and feral pigs are fenced out of the area, and invasive alien plant species are controlled. Wildfires are suppressed. Recently (mid-2000s), almost 40 hōlei seedlings were planted at Kīpuka Kī, and almost 70% survived 2–4 years (Belfield *et al.* 2011).

REMARKS: The natural habitat of hōlei has been much disturbed on both Maui and Hawai`i (Rock 1913), and the species, formerly abundant on Maui, is now rare. As the endangered Kīlauea hōlei is no longer present at Kīpuka Puauulu and is possibly extinct, Haleakalā hōlei may be considered a surrogate for the original species of the kīpuka.

CULTURAL USES/ETHNOBOTANY: Hawaiians produced a yellow dye from the bark and roots of some hōlei species (Rock 1913, Abbott 1992).



Kīlauea hōlei, *Ochrosia kilaueaensis*
 (No photo)

COMMON NAME: **Hōlei, Kīlauea hōlei**

SCIENTIFIC NAME: *Ochrosia kilaueaensis*

FAMILY: Apocynaceae (Dogbane Family)

SYNONYMS: *Ochrosia konaensis*, *O. sandwicensis* (Kīpuka Puaulu plants treated as this species by Rock 1913.)

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Small to medium-size tree, 15–18 m tall. Leaves in whorls of 3–4 per node, oblanceolate to elliptic, 6–19 cm long and 2–6.5 cm wide, lateral veins conspicuous, petioles 1.5–2 cm long. Flowers in open axillary inflorescences, with peduncles 4.5–6 cm long and secondary peduncles 1–2.5 cm long; individual flowers greenish white, with a five-lobed calyx 10–11 mm long, and a tubular corolla 7–11 mm long with five lobes 12–15 mm long. Fruits are two-parted drupes with a smooth surface, 4.5–5 cm long and less than 3 cm wide, probably yellowish-brown at maturity. Seed large, one in each part of fruit (St. John 1978a, Wagner *et al.* 1999). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island at elevations of 670 and 1,220 m (2,200–4,000 ft), where specimens were collected only at Kīpuka Puaulu and Pu`uwa`awa`a. Possibly extinct.

HAVO DISTRIBUTION: Within HAVO, Kīlauea hōlei was known only from Kīpuka Puaulu, where the last tree was observed (and a specimen collected) in 1927 (St. John 1978a). Extirpated from the park.

HABITAT: Montane mesic forest. In HAVO, the Kīlauea hōlei was found in montane mesic forest of koa, `ōhi`a lehua, and mānele.

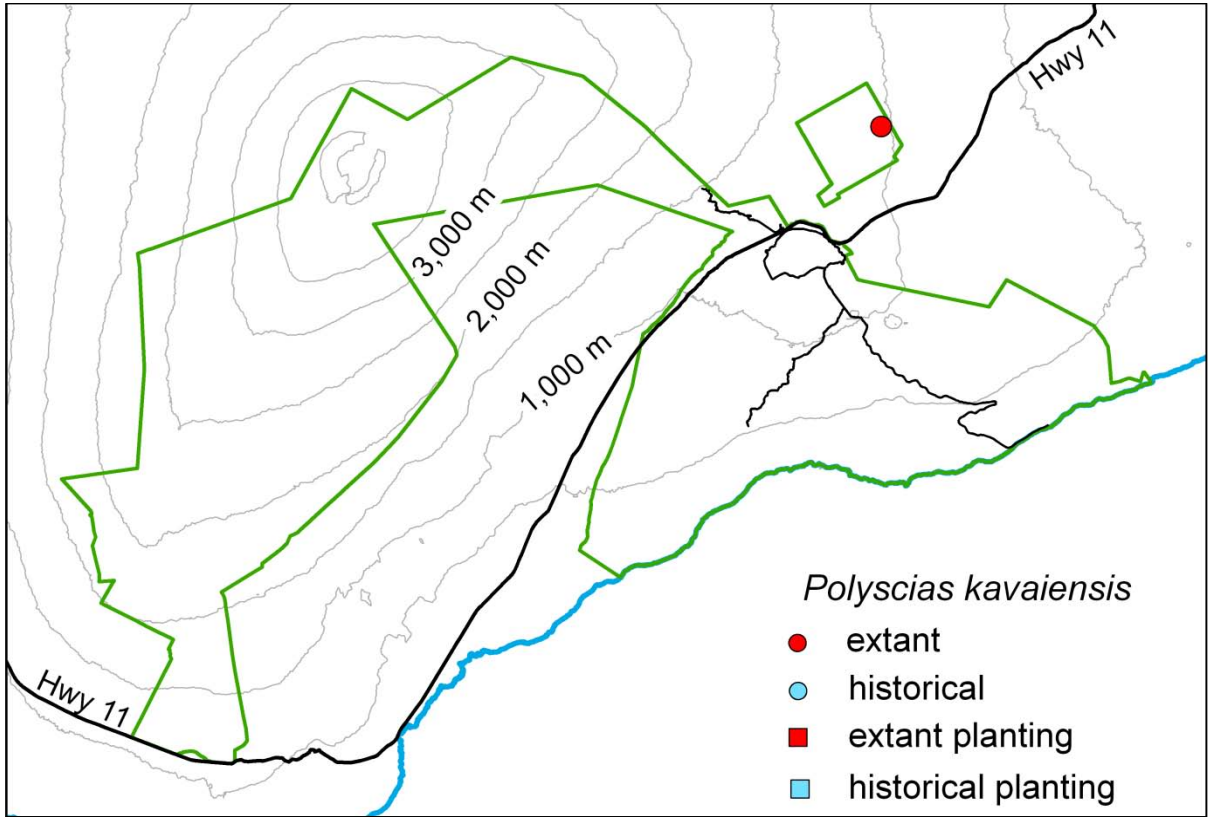
SIMILAR SPECIES: *Ochrosia haleakalae*, which now grows at Kīpuka Puaulu (see account for that species), is very similar in appearance to *O. kilaueaensis* and differs in having shorter calyx lobes (3–4 mm long) and corolla lobes (7–11 mm) versus calyx lobes 10–11 mm long and corolla lobes 12–15 mm long in *O. kilaueaensis*. The fruits of *O. haleakalae* are usually ridged, and those of *O. kilaueaensis* are smooth (Wagner *et al.* 1999).

THREATS: Domestic cattle, feral goats, feral sheep, and mouflon sheep are threats to any hōlei trees remaining in dry forest of Pu`uwa`awa`a. Alien grasses and wildfire are threats to both dry and mesic forests. Rats are listed as potential seed predators by the U.S. Fish and Wildlife Service (1996).

MANAGEMENT/RESTORATION STRATEGIES: No propagation efforts were made for Kīlauea hōlei before it disappeared from Kīpuka Puaulu. When re-introduction was attempted in the 1950s, seeds were collected from East Maui, because hōlei on Maui were thought to be the same species as the hōlei of HAVO. Trees propagated from this material were successfully out-planted into Kīpuka Puaulu. Subsequently, the two species (*O. haleakalae* and *O. kilaueaensis*) were named and recognized as distinct (St. John 1978a). The habitat of this possibly extinct hōlei is now protected from ungulates, invasive alien plants, and wildfire within Kīpuka Puaulu Special Ecological Area.

REMARKS: Kīlauea hōlei has not been observed recently at the two sites that formerly supported it. No photograph is available for this species.

CULTURAL USES/ETHNOBOTANY: Hawaiians produced a yellow dye from the bark and roots of some hōlei species (Rock 1913); it is not known whether this particular species was utilized for this purpose.



`Ohe`ohe, *Polyscias kawaiensis*
(No photo)

COMMON NAME: **`Ohe`ohe**

SCIENTIFIC NAME: *Polyscias kawaiensis*

FAMILY: Araliaceae (Ginseng Family)

SYNONYMS: *Tetraplasandra kawaiensis*, *T. kawaiensis* var. *grandis*

FEDERAL AND STATE STATUS: No status (federal), Species of Concern (state of Hawai`i)

DESCRIPTION: Tall tree to 25 m in height. Leaves pinnately compound 25–90 cm long. Leaflets 11–21 ovate to narrow-oblong, 6–20 cm long and 3–8 cm wide, lower surface densely covered with matted hairs, base and apex rounded, leaflet stalks 5–12 mm long. Inflorescence a complex arrangement of umbels and rays along a central stalk (raceme). Inflorescence stalk thick 5–10 cm long, secondary axes or rays pendent 15–30 cm long, ultimate branches 3–10 cm long, flower stalks 3–8 mm long. Flowers with a short calyx; petals six to eight, yellow-green, lanceolate, 5–7 mm long; stamens six to eight; ovary with two to five sections (carpels), stigmas 2–5, sessile on a disk. Fruits are small globose, ovoid, or cylindrical drupes, purple, 10–15 mm long with a ring at the middle and a rounded disk on top; fruits are ribbed when dry. Seeds small (Wagner *et al.* 1999). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: **Kaua`i, O`ahu, Lāna`i, Maui, and Hawai`i; 650 to 1,650 m** elevation. There are thousands of trees of this species on Kaua`i (S. Perlman, pers. comm.), but this `ohe`ohe is rare on the other four islands (Wagner *et al.* 1999).

HAVO DISTRIBUTION: **`Ōla`a Forest** near its eastern boundary with Pu`u Maka`ala Natural Area Reserve, at 1,000 m (3,300 ft) elevation. Only one tree of this species has been recently observed within HAVO.

HABITAT: Montane **`ōhi`a lehua/hāpu`u wet forest.**

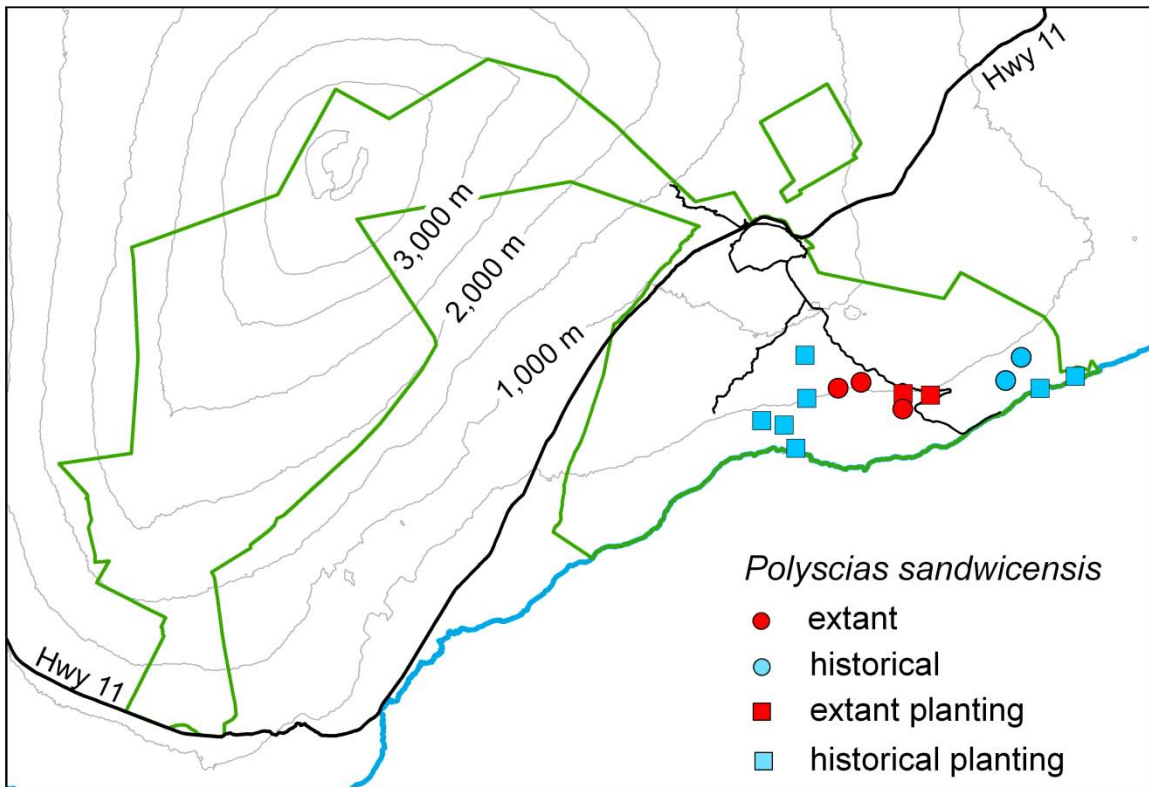
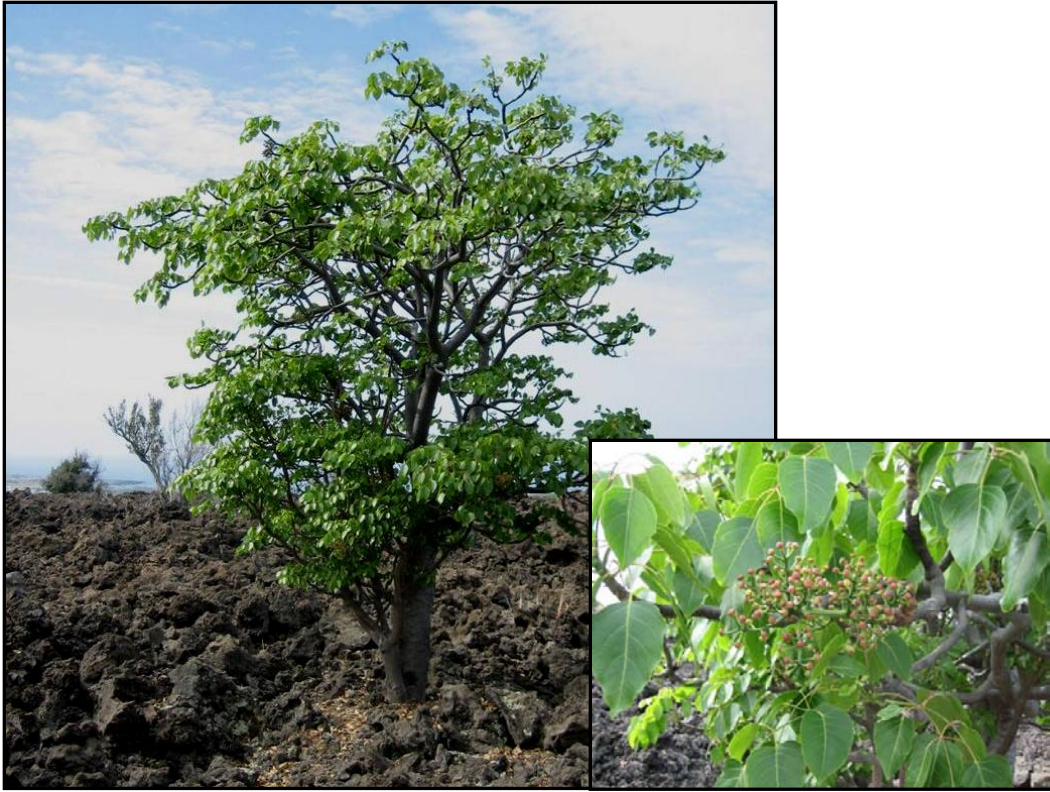
SIMILAR SPECIES: The only other species of *Polyscias* in **`Ōla`a Forest** is **`ohe mauka**, *P. oahuensis*, which is a smaller tree with smaller pinnately compound leaves (15–35 cm long) with fewer leaflets (7–15) that have smooth, not hairy, undersides. The only **other member of the same family** in **`Ōla`a Forest** is **`ōlapa** (*Cheirodendron trigynum*), which has palmately compound leaves with three to five toothed ovate leaflets.

THREATS: Feral pigs are not controlled and alien plants are well established in this unfenced part of **`Ōla`a Forest**. **Palmgrass** has dense cover in the area that supports `ohe`ohe, and strawberry guava and yellow Himalayan raspberry are also present.

MANAGEMENT/RESTORATION STRATEGIES: No management actions are currently directed at `ohe`ohe; HAVO may not actually support a population of this species. This `ohe`ohe is not currently a target of restoration attempts for either HAVO (S. McDaniel, pers. comm.) or the island-wide Plant Extinction Prevention Program (K. Bio, pers. comm.). Targeted **searches of the tree's likely habitat in `Ōla`a may be needed to** determine if an actual population exists in HAVO; if trees are found propagation material could be collected.

REMARKS: HAVO may be on the edge of the natural range of this `ohe`ohe. In 2010, all members of the genus *Tetraplasandra* were transferred to the genus *Polyscias* (Lowry and Plunkett 2010).

CULTURAL USES/ETHNOBOTANY: None known; the wood of members of this genus is soft and of no use as timber (Rock 1913).



Ohe makai, *Polyscias sandwicensis*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **`Ohe makai, `Ohe, `Oheokai**

SCIENTIFIC NAME: *Polyscias sandwicensis*

FAMILY: Araliaceae (Ginseng Family)

SYNONYMS: *Reynoldsia sandwicensis*; *R. degeneri*; *R. hillebrandii*; *R. hosakana*; *R. huehuensis*, *R. h. var. brevipes*, *R. h. var. intermedia*; *R. mauiensis*, *R. m. var. macrocarpa*; *R. oblonga*; *R. sandwicensis var. intercedens*, *R. s. var. molokaiensis*; *R. venusta*, *R. v. var. lanaiensis*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Tree to 20 m in height; bark smooth and pale reddish; smaller branches fleshy. Leaves alternate, pinnately compound, 20–35 cm long, with 5–15 leaflets; each leaflet ovate to ovate-lanceolate, 7–10 cm long, with toothed margins, base of leaflet heart-shaped, yellowish-green. Flowers are borne in large complex inflorescences (paniculate-racemose) with thick stalk 5–30 cm long, flower stalks 1–10 mm long. Flower petals 8–12, greenish-yellow, tinged with orange or purple, fleshy, linear, 5–8 mm long; stamens 8–12, greenish-yellow, 4 mm long with yellow anthers 3 mm long; ovary with 8–10 sections (carpels), styles embedded in the ovary. Fruits are small globose drupes, dark purple, 6–8 mm in diameter with flat disk on top; fruits are ribbed when dry (Wagner *et al.* 1999). Seeds small. Phenology: Loses leaves in dry season (often summer); flowers in summer and fall (Culliney and Koebele 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: All main Hawaiian Islands, except Kaua`i and Kaho`olawe, at 30 to 800 m (100–2,620 ft) elevation.

HAVO DISTRIBUTION: Naturally occurring in the eastern coastal lowlands and planted in the central lowlands. Remaining natural trees are found along **Poliokeawe Pali near the trail from `Āinahou Ranch to coastal Keauhou, in a small kīpuka east of `Āinahou, and in Kealakomo kīpuka (Abbott and Pratt 1996)**. Before recent lava flows destroyed many lowland forests of HAVO, `ohe makai trees were numerous on a **prehistoric `a`ā flow upslope of Kamoamoa and in small kīpuka on Paliuli Pali**; a few planted at Waha`ula and coastal Kamoamoa were also destroyed by lava. **Recently planted at Nāulu and Kealakomo.**

HABITAT: Lowland dry to mesic forest; sometimes in open **vegetation on old `a`ā flows.**

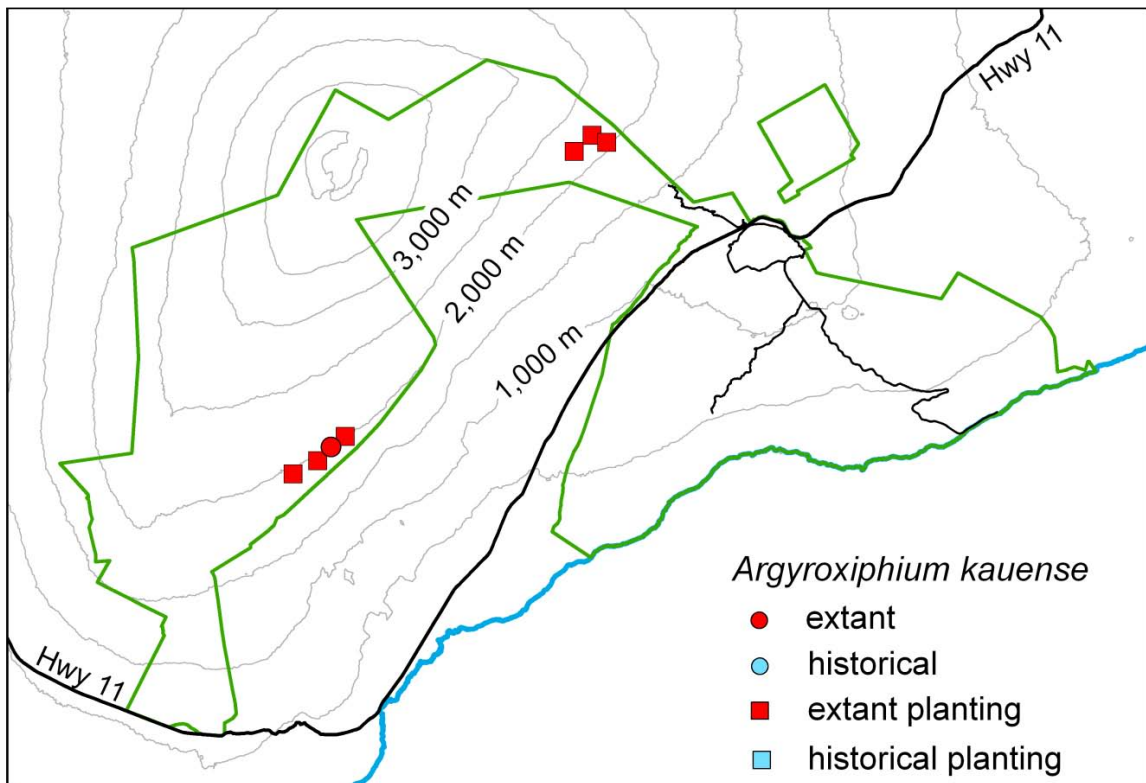
SIMILAR SPECIES: `Ohe makai is superficially similar to other native species in the genus *Polyscias*. The only *Polyscias* found in eastern HAVO is *P. hawaiensis* (`ohe), which grows in wet to mesic forests at somewhat higher elevation. *Polyscias hawaiensis* is a tall tree with pinnately-compound leaves that are conspicuously silvery-white hairy on the undersides.

THREATS: Feral goats are a threat in unprotected areas. Rats are suspected seed predators of this species. Fire is a threat to lowland habitats invaded by alien grasses. Lava flows have destroyed most of **the tree's habitat in HAVO.**

MANAGEMENT/RESTORATION STRATEGIES: Feral goats were removed from the HAVO coastal lowlands in the 1970s, and fires are suppressed. Most `ohe makai trees of HAVO have been destroyed by lava **since 1985. Multiple plantings in the 1970s in lower `Āinahou and along the Keauhou Trail to the coast failed (N. Zimmer, unpublished data)**. Recently (2001–2003) more than 400 plants were planted at **Nāulu and Kealakomo**, and survival at Kealakomo was almost 50% after seven years (Belfield *et al.* 2011). `Ohe makai may also be appropriate for introduction to Kahuku Unit. Research into methods to reduce rat impacts may be warranted.

REMARKS: Sherff (1952) described seven species and five varieties of Hawaiian *Reynoldsia*. Wagner *et al.* (1999) recognized only a single variable species in Hawai`i. In 2010, members of the genus *Reynoldsia* were transferred to *Polyscias* (Lowry and Plunkett 2010).

CULTURAL USES/ETHNOBOTANY: Hawaiians made use of the resinous sap of this tree and used the wood in construction (Rock 1913). Krauss (1993) reported other uses for the wood.



`Āhinahina, Ka`ū silversword, *Argyroxiphium kauense*

Photos: Thomas Belfield, PCSU/NPS, HAVO; Linda Pratt, USGS, PIERC, flowers

COMMON NAME: **ʻĀhinahina, Ka`ū silversword, Mauna Loa silversword**

SCIENTIFIC NAME: *Argyroxiphium kauense*

FAMILY: Asteraceae (Sunflower Family)

SYNONYMS: *Argyroxiphium sandwicense* var. *kauense*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1993

DESCRIPTION: Single-stemmed rosette shrub, 70 cm tall when sterile, to 2.5 m tall when flowering. Leaves silver to gray, very narrow and sword-shaped, three-angled, 20–40 cm long and <0.7 cm wide in middle, covered with silky hairs. Flowers are borne in hundreds of daisy-like heads arranged in narrow, racemose inflorescences 70–220 cm long. Heads are surrounded by 22–40 bracts; ray florets 3–11 per head, 4–7 mm long, white, yellow or red, three-lobed; disk florets 50–200 per head, corolla hairless, white or yellow at base, wine-red at tip, 4–6 mm long; pappus of disk florets composed of 3–9 unequal scales to 3 mm long. Fruits are dry achenes, 6–10 mm long, bowed. Phenology: Flowers in August–September. Monocarpic; plants die after flowering and fruiting once (Carr 1985, Wagner *et al.* 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island; known from few sites on Mauna Loa from 1,625 to 1,900 m (5,330–6,230 ft) elevation (**Kahuku Unit, Kapāpala Forest Reserve, Upper Waiākea Forest Reserve**); formerly on Hualālai (Wagner *et al.* 1999).

HAVO DISTRIBUTION: This silversword is found at Kahuku Unit in an area known as Ke a Pohina, at 1,830 m (6,000 ft) elevation. It is not known to occur elsewhere within HAVO, but there is a natural **population at Kapāpala, <10 km west of the strip**. The Ka`ū species was introduced to several sites on HAVO Mauna Loa Strip in 1975–1979, and in 1999–2005 thousands were planted in two exclosures on the Mauna Loa Strip near 2,135 m (7,000 ft) elevation. Plantings have also been made in three new unguilate-proof exclosures at Kahuku.

HABITAT: Subalpine woodlands, montane wet forest, and bogs.

SIMILAR SPECIES: Ka`ū silversword most resembles the Mauna Kea silversword (*A. sandwicense* var. *sandwicense*), from which the Ka`ū silversword may be distinguished by its narrower, silvery-gray leaves and fewer ray florets on flowering heads. The leaves of the Mauna Kea silversword are brilliant silver in color and so densely hairy that the leaf surface is obscured.

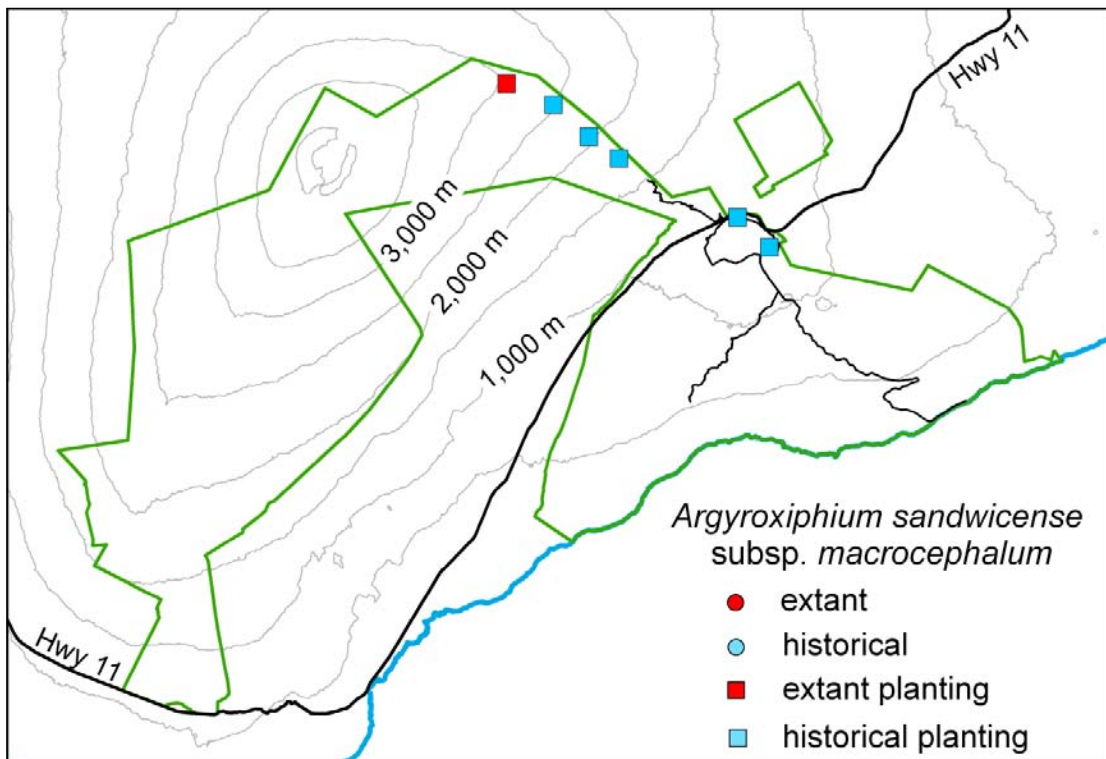
THREATS: Mouflon sheep and feral animals, including goats, sheep, and pigs, are serious threats to the silversword. Loss of pollinators may also threaten this obligate out-crosser. The alien Argentine ant may reduce native pollinators, although this is a potential threat, as ants are not yet established near park silversword populations at Kahuku (R. Peck, pers. comm.).

MANAGEMENT/RESTORATION STRATEGIES: The natural population of **Ka`ū silversword** at Ke a Pohina and three planted exclosures also at Kahuku, are protected from unguilates by a fence. **Eighteen Ka`ū silverswords** from Kahuku seeds were planted near the top of the Mauna Loa Road in 1975, but most died. Seeds from this planting were used to introduce silverswords at a site on the Mauna Loa Strip at 2,075 m elevation; all were lost when a single mouflon sheep breached the fence and killed the plants. Subsequently, two exclosures were constructed at 2,075 and **2,135 m elevation, and plants of Kapāpala** seed stock were planted. Survival was initially good (A. Bakutis, pers. comm.). Park managers are working with other organizations to recover the silversword, and more than 15,000 have been planted on Mauna Loa. Managed breeding, propagation, and monitoring are components of this recovery program. There is a vehicle sanitation procedure to prevent ant introductions at Kahuku.

REMARKS: All three **known natural populations of the Ka`ū silversword** are now protected within fenced exclosures. Many botanists prefer use of the name Mauna Loa silversword because the species is not **restricted to the district of Ka`ū**.

CULTURAL USES/ETHNOBOTANY: None known.

Introduced to HAVO



ʻĀhinahina, Haleakalā silversword, *Argyroxiphium sandwicense* subsp. *macrocephalum*
Photo: W. L. Wagner, © Smithsonian Institution Botany Department

COMMON NAME: **ʻĀhinahina, Haleakalā silversword**

SCIENTIFIC NAME: *Argyroxiphium sandwicense* subsp. *macrocephalum*

FAMILY: Asteraceae (Sunflower Family)

SYNONYMS: *Argyroxiphium macrocephalum*, *A. sandwicense* var. *macrocephalum*

FEDERAL AND STATE STATUS: Threatened Subspecies, listed in 1992

DESCRIPTION: Single-stemmed rosette shrub, rarely branched, up to 3 m tall when flowering. Leaves bright silver, succulent, very narrow and sword-shaped, three-angled, 15–40 cm long and 0.5–1.5 cm wide in the middle, silky and wooly hairs completely obscuring leaf surface. Flowers are borne in large, showy, daisy-like heads; 50–600 heads are arranged in racemose to paniculate inflorescences 70–250 cm long and 15–75 wide, elliptic to lanceolate in outline, 1.5–4 times longer than broad. Heads surrounded by 31 to 115 bracts, each 1–2.4 cm long, some heads with 20 more bracts among disk florets; ray florets 11–42 per head, pink to wine-red, three-lobed, tubular at base and flatten into a ray 6–20 mm long and 2–6 mm wide; disk florets 50–260 per head, corolla pink to red at tip, yellowish at base, 5–8 mm long, sometimes with hairs at base; pappus of ray florets reduced, pappus of disk florets composed of 3–10 scales to 5 mm long. Fruits are achenes, 7–15 mm long, straight or curved (Wagner *et al.* 1999). Phenology: Flowers June–November. Monocarpic, dying after flowering and fruiting once (Carr 1985).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to East Maui at 2,125–3,750 m (6,970–12,300 ft) elevation; not native to HAVO but planted in the Mauna Loa Strip.

HAVO DISTRIBUTION: Planted at Pu`u `Ula`ula (Red Hill), at a site along the Mauna Loa Trail near 2,590 m elevation, at the end of the strip road, and at a lower site along the road in 1953–54. **The earliest silversword plantings were at Byron’s Ledge in 1927 and Kilauea Military Camp in 1952; they did not survive (Morris 1967).** Plants persist at Pu`u `Ula`ula as well as a silversword population of unconfirmed identity south of the hill possibly established through dispersal.

HABITAT: Natural habitat is alpine stone desert of Haleakalā, Maui. The HAVO planting sites are vegetated with sparse native shrubs, mosses, and lichens or are subalpine shrublands.

SIMILAR SPECIES: Haleakalā silversword is very similar to Mauna Kea silversword (*A. sandwicense* subsp. *sandwicense*) of Hawai`i Island, from which it differs in the shape and greater broadness of the **inflorescence and the greater number of ray florets per flower head.** Ka`ū silversword (*A. kauense*) may be distinguished by its silvery-gray, very narrow, flat leaves with hairs that do not completely obscure the leaf surface. Its flower heads are smaller and have fewer bracts and ray florets than either subspecies of *A. sandwicense*. Hybrids between the taxa would have intermediate morphology.

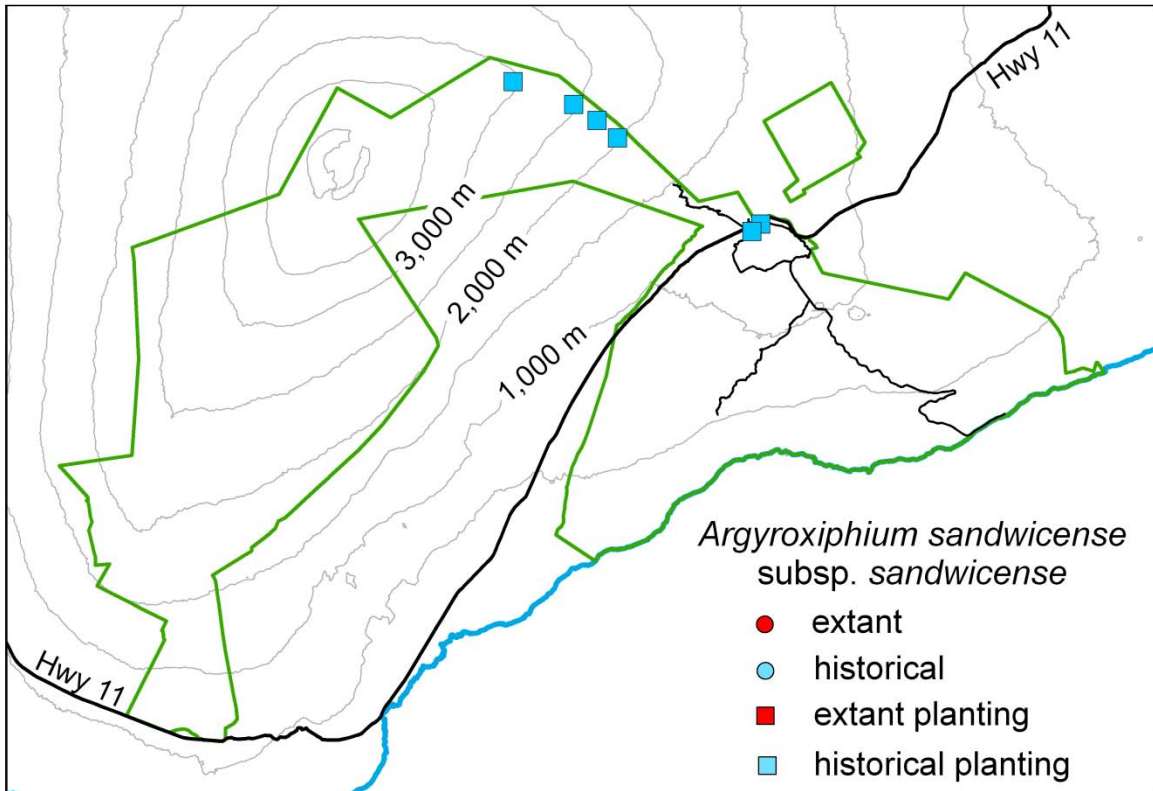
THREATS: In its natural habitat, the Haleakalā silversword was threatened by feral goats until Haleakalā Crater was fenced and goats were removed. Mouflon sheep, feral goats, sheep, and pigs are potential threats to any desired plantings. Argentine ants are a threat to native insect pollinators of silversword. Hybridization is a potential threat when related taxa are nearby.

MANAGEMENT/RESTORATION STRATEGIES: Out-plantings of the Haleakalā silversword were made at a time when species **differences were not well understood.** Because the Ka`ū silversword is now being planted in HAVO and the species are capable of hybridizing (Carr 1985), it may be important to prevent mixing of the two **species.** Possible first steps are mapping Haleakalā silverswords remaining in the park and confirming identity of the population near Pu`u `Ula`ula.

REMARKS: This subspecies is not native to Hawai`i Island. Removal of feral goats within the natural **habitat at Haleakalā Crater led to an increase in Haleakalā silverswords (Loope and Crivellone 1986),** although the number of silverswords has recently declined (Starr *et al.* 2009, 2011).

CULTURAL USES/ETHNOBOTANY: None known.

Introduced to HAVO



ʻĀhinahina, Mauna Kea silversword, *ArgYROXIPHIUM SANDWICENSE* subsp. *SANDWICENSE*
Photo: W. L. Wagner, © Smithsonian Institution Botany Department

COMMON NAME: **ʻĀhinahina, Mauna Kea silversword**

SCIENTIFIC NAME: *Argyroxiphium sandwicense* subsp. *sandwicense*

FAMILY: Asteraceae (Sunflower Family)

SYNONYMS: *Argyrophyton douglasii*, *Argyroxiphium sandwicense* var. *sandwicense*

FEDERAL AND STATE STATUS: Endangered Subspecies, listed in 1986

DESCRIPTION: Single-stemmed rosette shrub, rarely branched, up to 3 m tall when flowering. Leaves bright silver, succulent, very narrow and sword-shaped, three-angled, 15–40 cm long and 0.5–1.5 cm wide in middle, silky and wooly hairs completely obscuring leaf surface. Flowers are borne in large, showy, daisy-like heads; 50–600 heads are arranged in racemose to paniculate inflorescences 70–250 cm long and 15–75 wide, oblong in outline, ca. four to nine times longer than broad. Heads surrounded by 31 to 115 bracts, each 1–2.4 cm long, some heads with 20 more bracts scattered among disk florets; ray florets 5–20 per head, pink to wine-red, three-lobed, tubular at base and flattened into a ray 6–20 mm long and 2–6 mm wide; disk florets 50–260 per head, corolla pink to red at tip, yellowish at base, 5–8 mm long, sometimes with hairs at base; pappus of ray florets reduced, pappus of disk florets composed of three to ten scales, 5 mm long. Fruits are dry achenes, 7–15 mm long, straight or curved. Phenology: Flowering from June to November (Wagner *et al.* 1999). Monocarpic, dying after flowering and fruiting.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawaiʻi Island on Mauna Kea; now restricted **to a single natural population on Waipāhoehoe Gulch, the headwaters of the Wailuku River, near 2,850 m (9,350 ft) elevation.** Also planted at several localities on Mauna Kea.

HAVO DISTRIBUTION: Not native to HAVO. A small number of Mauna Kea silverswords were planted at Puʻu ʻUlaʻula, the end of the Mauna Loa Road, and within two exclosures along the Mauna Loa Trail in 1973–1975. **Plantings were also made at Kīlauea Military Camp and the Uwekahuna/Kīlauea Overlook area.** Most died or were removed as inappropriate plantings in the 1970s (N. Zimmer, unpublished data), and it is unlikely that plants of this species persist in HAVO.

HABITAT: Natural habitat is alpine stone desert and sparse subalpine shrublands of māmane, na`ena`e, and `ōhelo on Mauna Kea. In HAVO, the species was out-planted in subalpine shrublands of `ōhi`a lehua, pūkiawe, and `ōhelo.

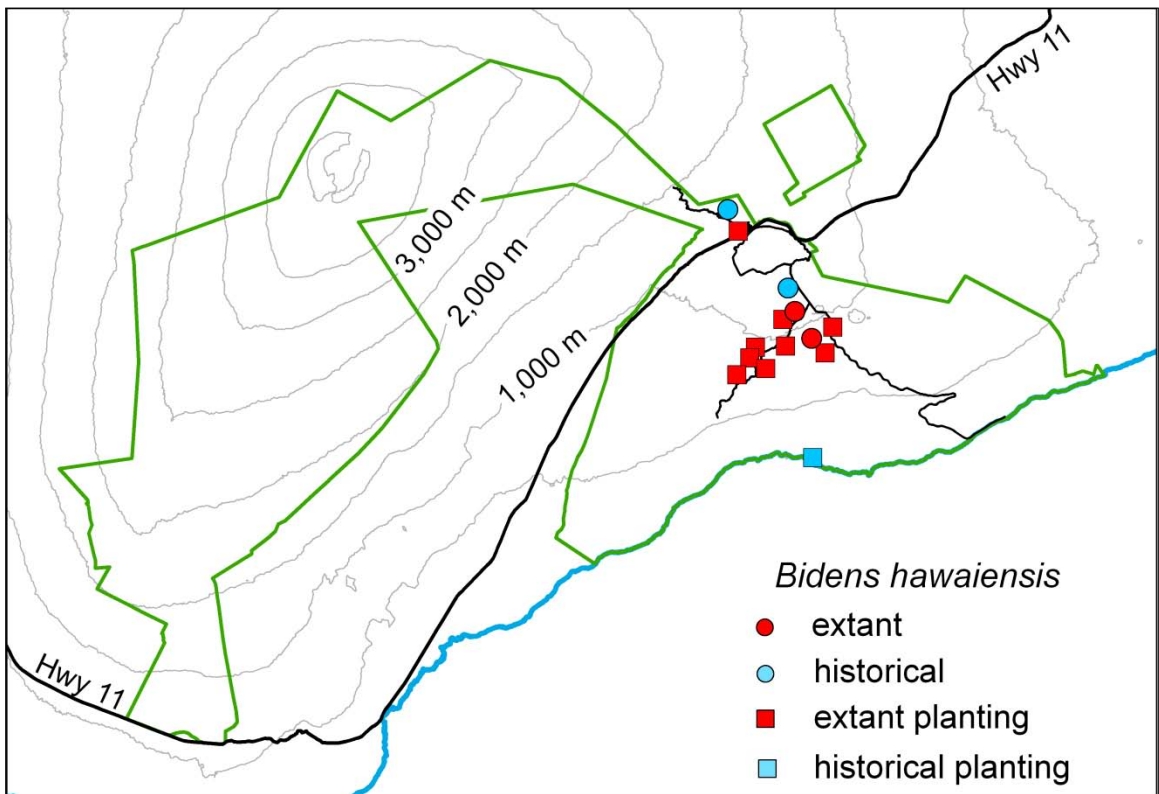
SIMILAR SPECIES: Mauna Kea silversword (*Argyroxiphium sandwicense* subsp. *sandwicense*) is very **similar to Haleakalā silversword** (*A. sandwicense* var. *macrocephalum*) from which it differs in the oblong **shape of the inflorescence and fewer ray florets.** **Ka`ū silversword** (*A. kauense*) may be distinguished by its silvery-gray, very narrow leaves with hairs that do not completely obscure the leaf surface. Its flower heads are smaller and have fewer bracts and ray florets than either subspecies of *A. sandwicense*.

THREATS: Feral sheep, goats, and pigs, as well as mouflon sheep, are the greatest threats to this species in its natural habitat. Domestic and feral cattle have done severe damage to silverswords in the past. Small population size, with concomitant loss of genetic diversity and increased threat of extinction, is a serious problem for this species.

MANAGEMENT/RESTORATION STRATEGIES: This species is not native to HAVO or Mauna Loa, and was perhaps an inappropriate introduction to the park. Previous out-planting sites could be revisited to confirm the status of this silversword, and any individuals remaining in HAVO could be considered for use **in recovery efforts on Mauna Kea. As with the Haleakalā silversword, it is important to prevent hybridization of plantings with the Ka`ū silversword.**

REMARKS: The Mauna Kea silversword was apparently a relatively common plant on upper Mauna Kea in the early 1800s (Douglas 1914).

CULTURAL USES/ETHNOBOTANY: None known.



Ko`oko`olau, Hawaii`i ko`oko`olau, *Bidens hawaiiensis*
 Photos: Linda Pratt, USGS, PIERC

COMMON NAME: **Ko`oko`olau, Hawai`i ko`oko`olau**

SCIENTIFIC NAME: *Bidens hawaiiensis*

FAMILY: Asteraceae (Daisy Family)

SYNONYMS: *Bidens skottsbergii*, *B. skottsbergii* var. *conglutinata*

FEDERAL AND STATE STATUS: No status (federal), Species of Concern (state of Hawai`i)

DESCRIPTION: Shrubby perennial herb to 2.5 m tall. Leaves simple, oblong-ovate, 7–16 cm long and 2–6 cm wide, smooth or sparsely hairy on veins, margins with forward-pointing teeth, leaf base cuneate. Flower heads in large compound inflorescences at tips of main stem and branches. Flower heads 4–5 cm in diameter with 7–10 yellow ray florets 18–26 mm long and 22–32 small yellow disk florets. Fruits are dry black achenes with two barbed awns (Wagner *et al.* 1999). Phenology: Flowers are observed in both summer and winter based on specimens in the HAVO Herbarium.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island. Occurs in three distinct areas between 50 and 1,400 m (165–4,590 ft) elevation: Kohala, **Puna District, and Kīlauea** (Wagner *et al.* 1999).

HAVO DISTRIBUTION: `Āinahou Ranch (Fosberg 1966) and along the upper Hilina Pali Road. Formerly found near Kīpuka Puaulu and near Ko`oko`olau Crater on the upper Chain of Craters Road (Degener 1975). Planted and persisting at `Āinahou and the upper Hilina Road (N. Zimmer, unpublished data), on road scars along the Chain of Craters Road, and at Kīpuka Nēnē. Recently planted in the broomsedge burn near Kīpuka Puaulu (Loh *et al.* 2007), and at four sites along the middle Hilina Pali Road (Belfield *et al.* 2011). Early plantings at coastal Keauhou did not survive the tidal wave of 1975.

HABITAT: In HAVO, ko`oko`olau is found in open `ōhi`a lehua woodland with native shrubs between 900 and 1,200 m (2,950–3,940 ft.) elevation.

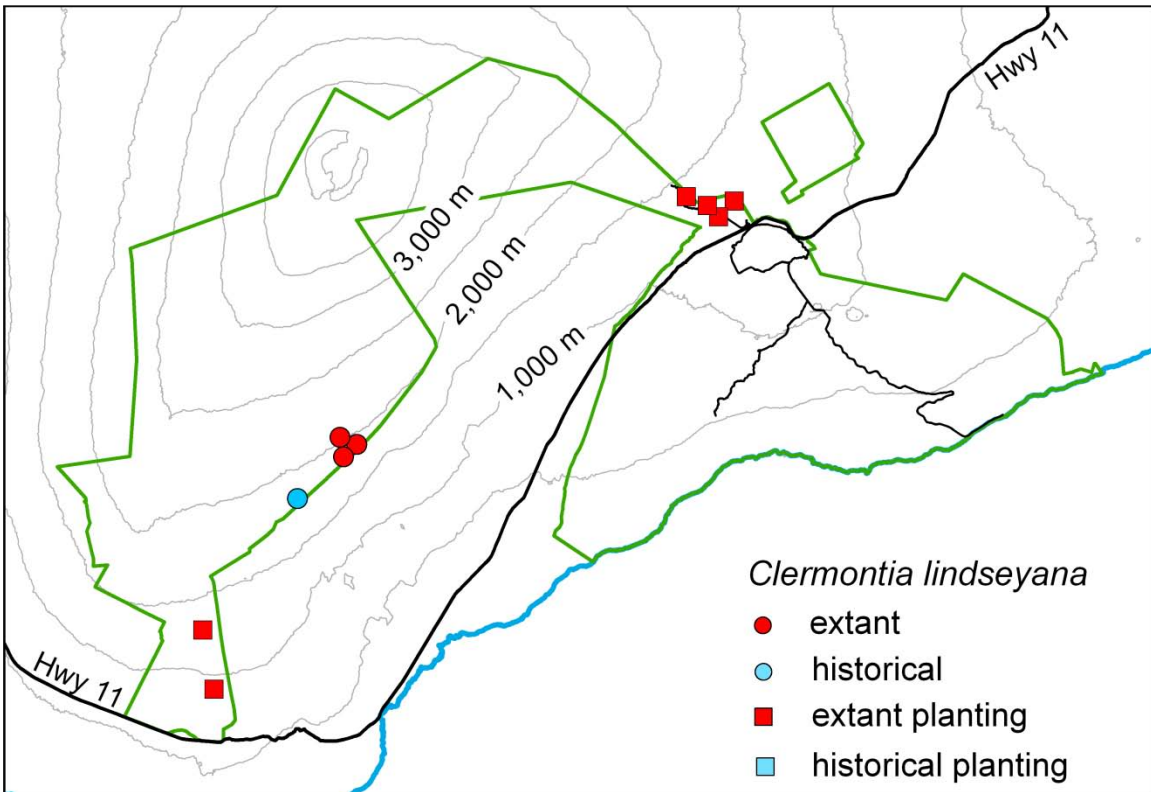
SIMILAR SPECIES: This is the only native ko`oko`olau known within HAVO, but two related alien species are found in the same habitat. The most common of these is Spanish needle (*Bidens pilosa*), sometimes called ko`oko`olau. This weedy herb may be distinguished from the native ko`oko`olau by its smaller size, pinnately compound leaves with three to five thin leaflets, and smaller flower heads about 1 cm in diameter. A second less common alien species is *Bidens cynapiifolia*, an annual herb with pinnately or bipinnately compound leaves and much smaller flower heads with few pale yellow ray florets.

THREATS: Feral goats were likely threats to ko`oko`olau in the past. The dry woodland habitat of ko`oko`olau has been invaded by the fast-growing faya tree and alien grasses. Wildfire is a potential threat.

MANAGEMENT/RESTORATION STRATEGIES: Feral goats have been removed from the dry woodlands of HAVO, and faya is controlled in portions of ko`oko`olau habitat. Wildfires are suppressed throughout HAVO. Ko`oko`olau has been augmented with plantings near two natural populations, and the species has been restored to several sites where it formerly grew. A population of this ko`oko`olau was found near the coast east of HAVO, and this population was one of the seed sources for early park plantings (N. Zimmer, unpublished data). At the broomsedge burn restoration site, >80% of ko`oko`olau plantings survived for several years and produced seeds (Loh *et al.* 2007). Recent plantings along Hilina Road were successful with more than a third of >600 plants still alive after four years (Belfield *et al.* 2011).

REMARKS: This shrubby ko`oko`olau may be a short-lived plant. The species seems to be reproducing and maintaining itself at the two natural and augmented populations in HAVO.

CULTURAL USES/ETHNOBOTANY: The leaves and flowers of this and other native ko`oko`olau are used for tea, tonic, and other medicine (Krauss 2001).



`Ōhā, Lindsey's `ōhā, *Clermontia lindseyana*

Photos: Linda Pratt, USGS, PIERC

COMMON NAME: **`Ōhā, Lindsey's `ōhā**

SCIENTIFIC NAME: *Clermontia lindseyana*

FAMILY: Campanulaceae (Bellflower Family); Subfamily Lobelioideae

SYNONYMS: *Clermontia albimontis*, *C. hawaiiensis* var. *grandis*, *C. lindseyana* var. *livida*, *C. viridis*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Terrestrial or epiphytic shrubs or trees 2.5–6 m tall, with milky-white sap. Leaves oblanceolate or elliptic, blades 13–24 cm long, 3.8–6.5 cm wide, upper surface dark green, glabrous or sparsely pubescent along the midrib, lower surface pale green or purplish, pubescent, margins callose-crenulate, apex acuminate, acute, or obtuse. Flowers in pairs, pubescent, colored green or rarely tinged purple externally, white or cream colored with stamen column and anthers white and glabrous. Length of flower 7–8.5 cm. Fruit is orange, subglobose, 25 to 50 mm long and 25 to 40 mm wide (Wagner *et al.* 1999). Phenology: Flowers are usually borne in the summer and fruits appear in summer and fall, flowers may also be seen in other seasons (U.S. Fish and Wildlife Service 1996).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i and on the leeward slopes of Haleakalā, East Maui between 1,220 and 1,825 m elevation (4,000–6,000 ft). The nearest known populations outside the park are in Keauhou Ranch, Kūlani lands north and east of HAVO, Ka`ū Forest Reserve, and Kapāpala Forest Reserve.

HAVO DISTRIBUTION: Known from few plants in an area of the Kahuku Unit along the park boundary with Ka`ū Forest Reserve (Benitez *et al.* 2008); recently observed at additional sites at Kahuku along the boundary fenceline. Collected historically near the 1950 lava flow at Kahuku. Also planted at Kahuku and in the lower Mauna Loa Strip within three small kīpuka on the park boundary and in a forest between Kīpuka Puaulu and Kīpuka Kī (S. McDaniel, pers. comm.).

HABITAT: Montane wet and mesic forest of `ōhi`a lehua and koa; frequently observed growing as an epiphyte, which may be due to browsing and habitat damage by feral ungulates.

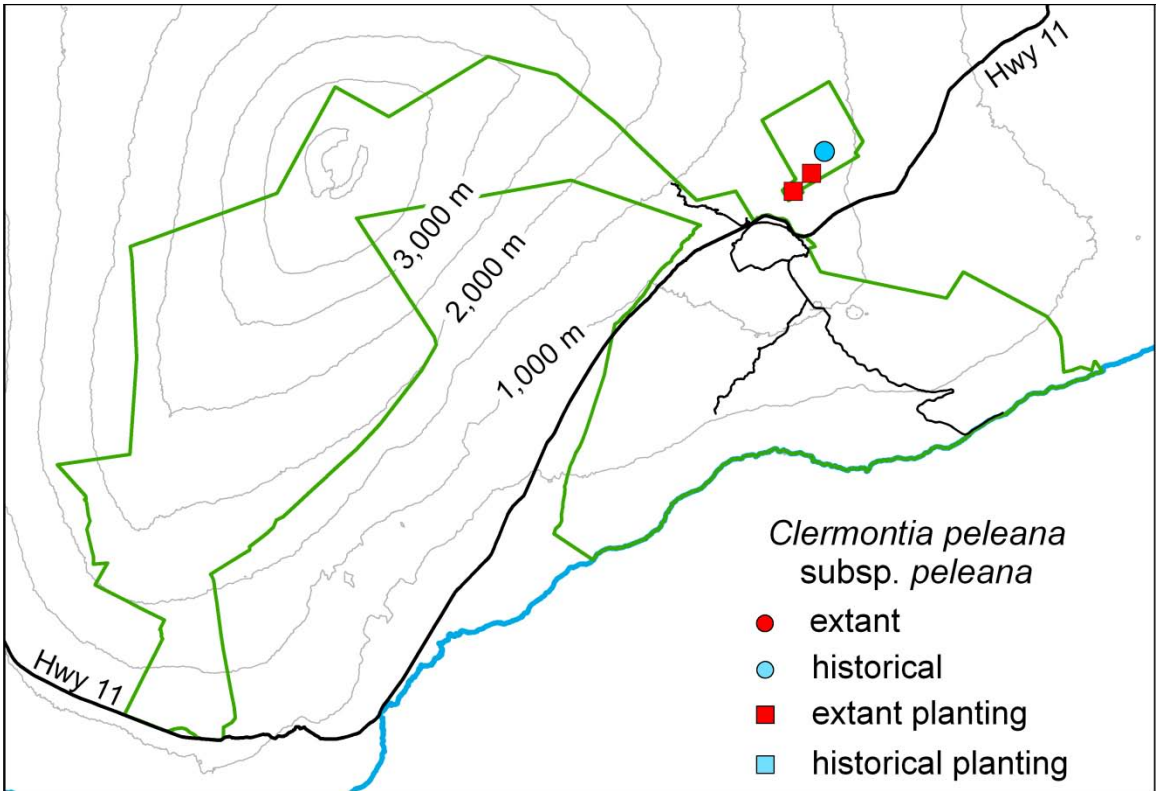
SIMILAR SPECIES: *Clermontia montis-loa* and *C. hawaiiensis* are vegetatively similar, and sterile plants of the species may be confused with one another. *Clermontia lindseyana* leaves are typically wider at the tip and more densely hairy on the undersides than are those of *C. montis-loa* or *C. hawaiiensis*. When flowers and fruit are present, *C. lindseyana* may be easily distinguished from other *Clermontia* by its large (>8 cm), sturdy, green and white flowers and globose, grooved (sulcate) orange fruit. *C. montis-loa* has purple flowers and smooth ovoid fruit, and *C. hawaiiensis* has smaller (<6.5 cm) green and white or purple-tinged flowers and bilaterally flattened fruit with ridges.

THREATS: Feral cattle, pigs, and mouflon sheep eat `ōhā plants and disturb the understory of forest habitat, which may eventually reduce the number of trees available to support epiphytes. Rats may depredate `ōhā fruits and strip bark during dry periods (U.S. Fish and Wildlife Service 1996). Loss of pollinators may have contributed to the species' decline.

MANAGEMENT/RESTORATION STRATEGIES: This species is an excellent candidate for propagation and restoration to Kahuku after montane wet and mesic forests there are protected from mouflon sheep and feral pigs. Recently, Lindsey's `ōhā seedlings were planted in two ungulate-free enclosures within the central pasture at Kahuku Unit and within three kīpuka in the lower Mauna Loa Strip, as well as at a rehabilitated forest site near Kīpuka Puaulu (S. McDaniel, pers. comm.). Large-scale reduction of rats has not yet been attempted. Pollination studies might provide useful information about this and other `ōhā species.

REMARKS: This species of `ōhā or *Clermontia* has the largest flowers known in the genus.

CULTURAL USES/ETHNOBOTANY: Fruits are edible, but their milky latex makes them unpalatable.



`Ōhā, Pele's `ōhā, *Clermontia peleana* subsp. *peleana*

Photos: Thomas Belfield, PCSU/NPS, HAVO, plant; W. L. Wagner, © Smithsonian Institution Botany Department, flower

COMMON NAME: **`Ōhā, Pele's `ōhā**

SCIENTIFIC NAME: *Clermontia peleana* subsp. *peleana*

FAMILY: Campanulaceae (Bellflower Family), Subfamily Lobelioideae (Lobelia)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Shrub or small tree up to 6 m in height, typically epiphytic. Leaves oblong with a short pointed tip and an acute base, 8–20 cm long and 3–5 cm wide, coriaceous in texture, glabrous, with small marginal teeth (denticulate or callose-crenulate); upper leaf surface dark green and glossy, lower surface paler green, sometimes with purple veins and midrib. Flowers one or two per inflorescence; corolla curved or strongly arched and dark purple or rarely greenish-white, 4–6 cm long, with an exerted staminal column bearing dark purple anthers; calyx lobe 1–2 mm long, triangular; flowers on pedicels 3–4.5 cm long and shorter peduncle (1.5 cm). Fruit is an orange, nearly globose berry 2.5–3 cm long and wide. Seeds small, about 1 mm in diameter, shiny brown (Rock 1919a, Degener and Degener 1960, Lammers 1991). Phenology: Flowers in summer and fall (U.S. Fish and Wildlife Service 1996).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Pele's `ōhā is endemic to the islands of Maui and Hawai`i, where it has been collected in rain forests of East Maui and windward Mauna Kea and Mauna Loa between 530 and 1,150 m elevation (1,740–3,770 ft) (Wagner *et al.* 1999). The type locality for the species is near Glenwood "...at an elevation of 3,800 ft, four or five miles below Kīlauea Volcano, along the government road" (Rock 1913, p. 483). Most recent sightings of this `ōhā have been in forests on the banks of the Wailuku River.

HAVO DISTRIBUTION: `Ōla`a Forest. Fosberg (1966) included Pele's `ōhā in his checklist of vascular plants of HAVO on the basis of the proximity of the type locality to the park and a specimen collected in `Ōla`a Forest in 1965 (D. Mueller-Dombois, pers. comm.). Naturally-occurring plants have not been observed within HAVO in >40 years. Recently planted at two sites in `Ōla`a Forest.

HABITAT: Montane wet forests, as an epiphyte on large `ōhi`a lehua trees.

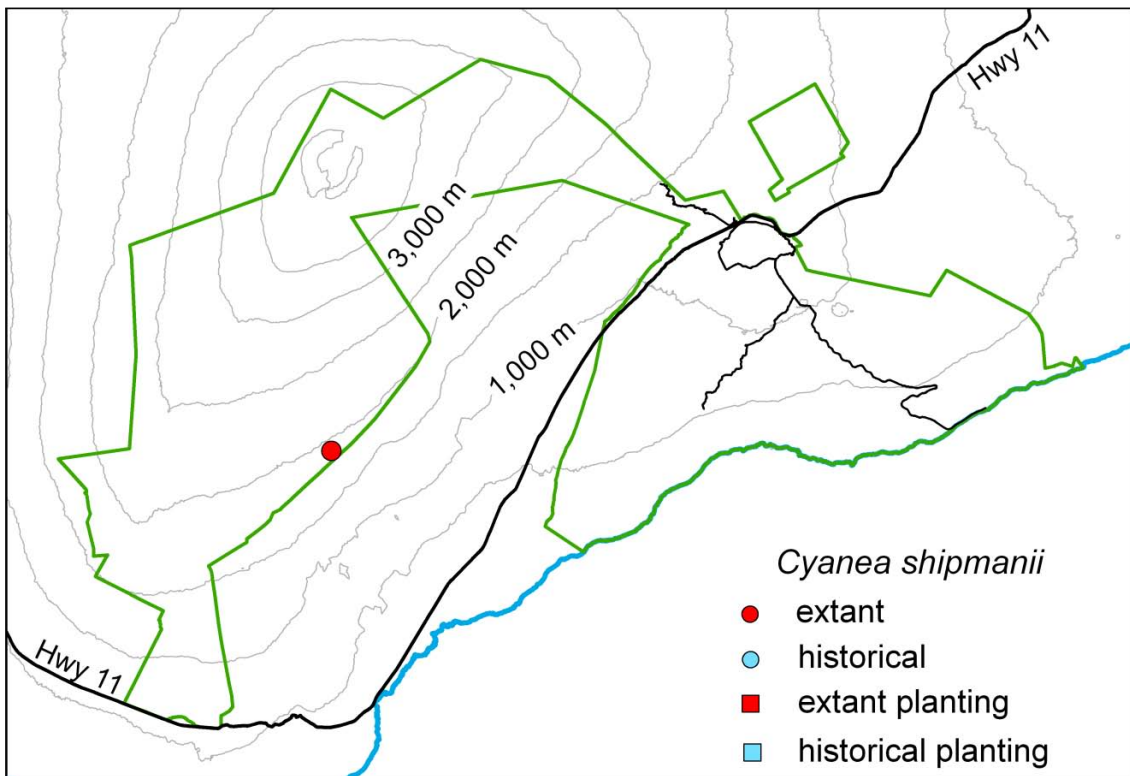
SIMILAR SPECIES: Sterile individuals of the common species *Clermontia parviflora* and the less common *C. hawaiiensis* superficially resemble the endangered *C. peleana*. When plants are flowering, *C. peleana* is unmistakable because of its distinctive dark purple, curved flowers with tiny triangular calyx lobes.

THREATS: Feral pigs eat plants, disturb the understory of rain forests, and may eventually reduce the number of trees available to support epiphytes. Rats may depredate `ōhā fruits and strip bark from plants. Loss of the birds that pollinated flowers of Pele's `ōhā may have contributed to the species' decline (U.S. Fish and Wildlife Service 1996).

MANAGEMENT/RESTORATION STRATEGIES: Fenced exclosures in `Ōla`a are pig-free and the most invasive alien plant species are controlled. Recently (2005–2008) propagation material was made available to HAVO, and more than 300 individuals of Pele's `ōhā were planted collectively in Koa Unit and Small Tract of `Ōla`a Forest; about 30% of plantings persisted for two to five years (Belfield *et al.* 2011). More plantings are planned for HAVO (S. McDaniel, pers. comm.). Experimental rat reduction techniques and pollination studies may be warranted for this species.

REMARKS: This species persists in low numbers and is in great danger of becoming extinct. The words of Joseph Rock, written in 1919, seem prophetic: "Like *Cl. Haleakalaensis*, *Cl. Peleana* is soon to be a thing of the past. It inhabits the tallest `Ōhi`a lehua trees, which, deprived of their native undergrowth, are ready to fall to their death, and with them this interesting *Clermontia*" (Rock 1919a, p. 297). HAVO may provide a protected site for a restored population.

CULTURAL USES/ETHNOBOTANY: None known.



Hāhā, Shipman's hāhā, *Cyanea shipmanii*
Photo: Sierra McDaniel, NPS, HAVO

COMMON NAME: **Hāhā, Shipman's hāhā**

SCIENTIFIC NAME: *Cyanea shipmanii*

FAMILY: Campanulaceae (Bellflower Family), Subfamily Lobelioideae (Lobelia)

SYNONYMS: *Cyanea grimesiana* var. *citrullifolia*, *Delissea shipmanii*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Shrub to 4 m in height, typically terrestrial; stem unbranched or with few branches at base and armed with prickles, particularly in juveniles. Leaves pinnately divided, cut almost to the midrib, 17–30 cm long and 7–14 cm wide, lower surface pubescent on veins, covered with prickles or sharp points, particularly so with juvenile leaves. Flowers 10 to 15 per inflorescence; corolla gently curved with spreading lobes as long as the tube, greenish-white, 3–3.6 cm long, with a densely pubescent staminal column, anthers pubescent with the lower two bearing tufts of white hairs; calyx lobe 3–6 mm long, oblong with an acute apex; flowers on pedicels 1–1.5 cm long and peduncle 1–3 cm (Wagner *et al.* 1999). Fruit is an ellipsoid berry reported to be purple (Rock 1957), although HAVO fruit are orange. Seeds small. Phenology: Flowers in the winter.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i Island endemic, known from windward Mauna Kea and Mauna Loa at elevations of 1,800–1,900 m (5,900–6,230 ft).

HAVO DISTRIBUTION: Recently discovered by HAVO Natural Resources Management (NRM) botanists at **one site in the Kahuku Unit on the upper boundary of the Ka`ū Forest Reserve at 1,830 m elevation.** Only one plant has been found at Kahuku.

HABITAT: Montane **mesic forest of `ōhi`a lehua and `ōhi`a/koa at relatively high elevation.**

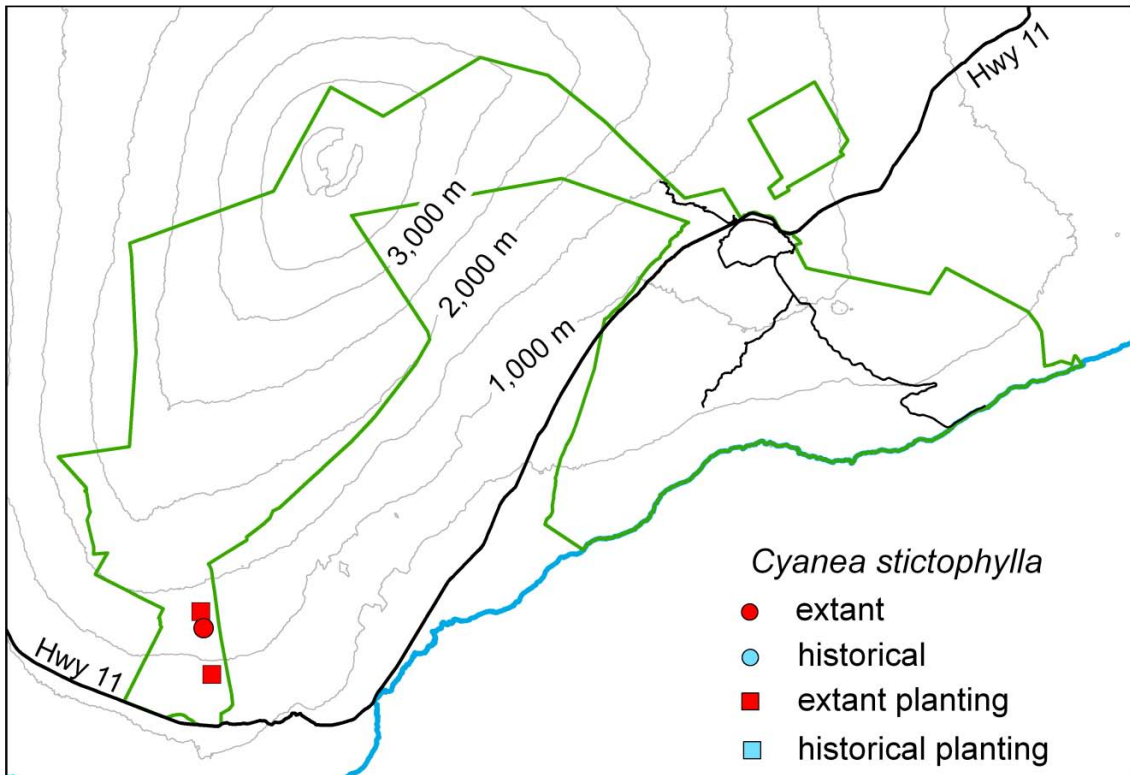
SIMILAR SPECIES: *Cyanea shipmanii* is the only hāhā on Hawai`i Island that has prickly pinnately-divided leaves, except for *C. cylindrocalyx* known only from Kohala. *Cyanea cylindrocalyx* has larger, less divided leaves and inflorescences with fewer flowers (6–12). Its flowers have much longer calyx lobes (20–27 mm) than do those of *C. shipmanii* (Lammers 1998, 2004; Wagner *et al.* 1999).

THREATS: Feral pigs, feral cattle, and mouflon sheep, **are the primary threats to this hāhā at Kahuku.** Rats are known to feed on the bark of this species (Rock 1957) and other lobelioids. The recovery plan for the species also lists the loss of pollinators and small population size as reasons for decline (U.S. Fish and Wildlife Service 1996).

MANAGEMENT/RESTORATION STRATEGIES: The single known tree of this species at Kahuku has been protected with temporary fencing, and the flowering phenology of the tree is being monitored. When fruit are produced, seeds will be collected for propagation in the HAVO greenhouse. An enclosure is planned in forest near the natural plant that will be suitable for planting seedlings derived from the Kahuku tree (S. McDaniel, pers. comm.) Eventually, a genetic management plan will be developed for the species, and future plantings at Kahuku will likely include seedlings from additional founder plants. Park botanists will continue to search for additional trees of this species when they carry out fenceline surveys and other work in the forests of Kahuku. Fencing of the boundary at Kahuku and reduction of mouflon sheep and feral pigs are in progress. Studies of rat-reduction techniques and pollination may be warranted.

REMARKS: The presence of this species was unexpected at Kahuku when it was discovered in 2009. The species was first named by Joseph Rock from plants found at Hakalau on Mauna Kea in 1955 (Rock 1957). **Subsequently, plants of the species were found in the Waiākea Forest Reserve near the Powerline Trail (T. Pratt, pers. obs.) and at two sites in and near Kūlanī (K. Bio, pers. comm.).** The habitat of this rare plant at Kahuku is **>40 km from the nearest known population at Pu`u Kipu, near Kūlanī.**

CULTURAL USES/ETHNOBOTANY: None known.



Hāhā, *Cyanea stictophylla*
Photo: Jonathan Price, HCSU/USGS, PIERC

COMMON NAME: **Hāhā**

SCIENTIFIC NAME: *Cyanea stictophylla*

FAMILY: Campanulaceae (Bellflower Family), Subfamily Lobelioideae (Lobelia)

SYNONYMS: *Cyanea nelsonii*, *C. palakea*, *C. quercifolia* var. *atropurpurea*, *C. stictophylla* var. *inermis*; *Delissea nelsonii*, *D. palakea*, *D. quercifolia* var. *atropurpurea*; *D. stictophylla*, *D. s.* var. *inermis*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Shrub or small tree up to 6 m in height, typically terrestrial; often unbranched and armed with prickles. Leaves narrowly oblong with shallow lobes, 20–40 cm long and 4–8 cm wide, glabrous, with small marginal teeth. Flowers five to six per inflorescence; corolla curved with spreading lobes, yellowish-white or purple, 3.5–5 cm long, with an exerted staminal column, some anthers with tufts of hairs; calyx lobe 2–4 mm long, triangular; flowers on pedicels 0.7–2 cm long and peduncle 1–4 cm long. Fruit is an orange, globose berry. Seeds small (Wagner *et al.* 1999). Phenology: Flowers in the winter or spring (U.S. Fish and Wildlife Service 1996).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i Island endemic, known from Kona and Ka`ū districts at elevations of 1,400–1,950 m (4,590–6,400 ft).

HAVO DISTRIBUTION: Currently known at a single small population located in a pit crater in the Kahuku Unit of HAVO. **This endangered species may formerly have occurred within `Ōla`a Forest, as it is present in Kīlauea Forest a few km northwest of `Ōla`a.** Also planted in two exclosures at Kahuku.

HABITAT: **Montane mesic and wet forest of `ōhi`a lehua and `ōhi`a/koa at relatively high elevation.**

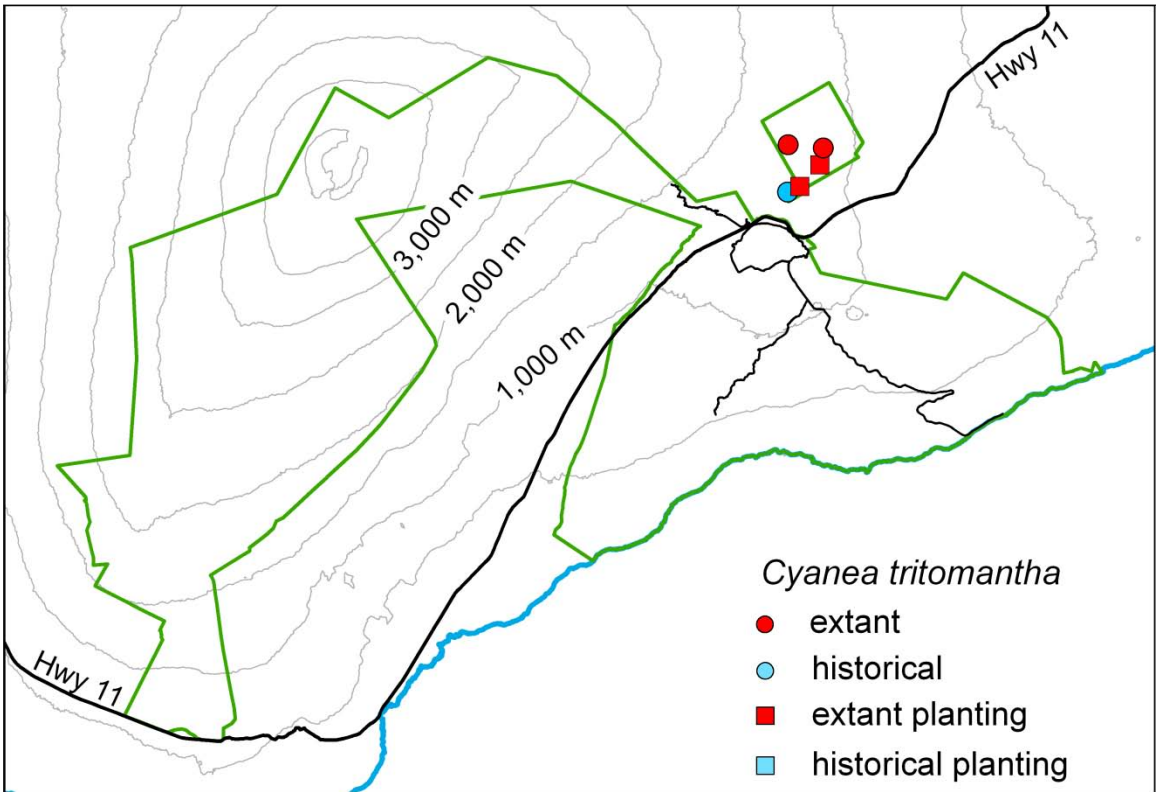
SIMILAR SPECIES: *Cyanea tritomantha*, *C. platyphylla*, and *C. marksii* are found in similar habitats on Hawai`i Island and might be confused with *C. stictophylla*. All four species bear prickles on leaves and stems, but differ in their floral characteristics. *Cyanea stictophylla* has flowers and fruits on short axillary stalks, and the triangular calyx lobes on flowers are only 2–4 mm long, shorter than those of the other similar species. None but *C. stictophylla* is found at Kahuku.

THREATS: Feral pigs, goats, and mouflon sheep are all threats to this soft-wooded species. **Cattle, where present, would likely browse the leaves and break branches of this hāhā. Rats may consume flowers and fruits and have been observed to girdle other hāhā (Rock 1957) and `ōhā species,** particularly during periods of drought (L. Pratt, pers. obs.).

MANAGEMENT/RESTORATION STRATEGIES: Fencing and reduction/removal of feral pigs and mouflon sheep **are underway at Kahuku. Seeds were collected from the hāhā plant(s) found at Kahuku Unit, and** plants have been propagated and planted within two ungulate-free exclosures on the east side of the central pastures (McDaniel *et al.* 2008). This species may be a priority for planting within additional protected sites at Kahuku; the nearest natural population that could provide additional propagation **material is in South Kona Forest Reserve (K. Bio, pers. comm.). `Ōla`a Forest might also provide** suitable habitat for this species, if seeds from wet forest-adapted plants were available from populations in adjacent state and private forests. Research into rat control methods may be useful, and management to reduce rats at plantings may promote planting success.

REMARKS: The Kahuku site is at slightly lower elevation (1,250 m) than that published for the species. **Although this hāhā is extremely rare, it has been found at scattered sites on Mauna Loa and Hualālai,** indicating that the species formerly had a wide distribution on the southern half of the island.

CULTURAL USES/ETHNOBOTANY: None known.



`Akū, *Cyanea tritomantha*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: `Akū

SCIENTIFIC NAME: *Cyanea tritomantha*

FAMILY: Campanulaceae (Bellflower Family), Subfamily Lobelioideae (Lobelia)

SYNONYMS: *Cyanea magnifica*, *C. submuricata*; *Delissea magnifica*, *D. submuricata*, *D. tritomantha*

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: Small, palm-like tree with fleshy stem often covered with stout prickles; leaves large and strap-like, oblanceolate, 40–95 cm long and 11–20 cm wide, lighter green on underside, with prickles particularly on midrib, leaf margins with fine teeth, petioles brittle 2–18 cm long, prickly; flowers in inflorescences of 5–20 flowers clustered in upper part of plant among leaves, calyx lobes narrowly triangular 10–25 mm long, corolla tubes black-purple to greenish-white, 60–75 mm long, slightly curved, and densely pubescent outside, staminal column with lower two of five anthers tufted with white hair; fruits are ellipsoid orange berries, 15–25 mm long and 10–22 mm wide, retaining persistent triangular calyx lobes. Seeds tiny (<0.5 mm), brown to black, shiny (Wagner *et al.* 1999). Phenology: Flowers are borne in winter, and fruits appear in spring.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island between 350 and 1,080 m elevation (1,150–3,540 ft), where it has been collected on Kohala Mountain, Mauna Kea, Mauna Loa (Wagner *et al.* 1999), and recently Kīlauea. The populations nearest HAVO are in Pu`u Maka`ala Natural Area Reserve and `Ōla`a Forest Reserve.

HAVO DISTRIBUTION: `Ōla`a Forest, primarily in the Koa and Ag Units (Pratt and Abbott 1997); formerly grew in the Small Tract, where it has recently been planted. Also planted in Koa Unit.

HABITAT: Montane wet forest with a dense understory of tree ferns.

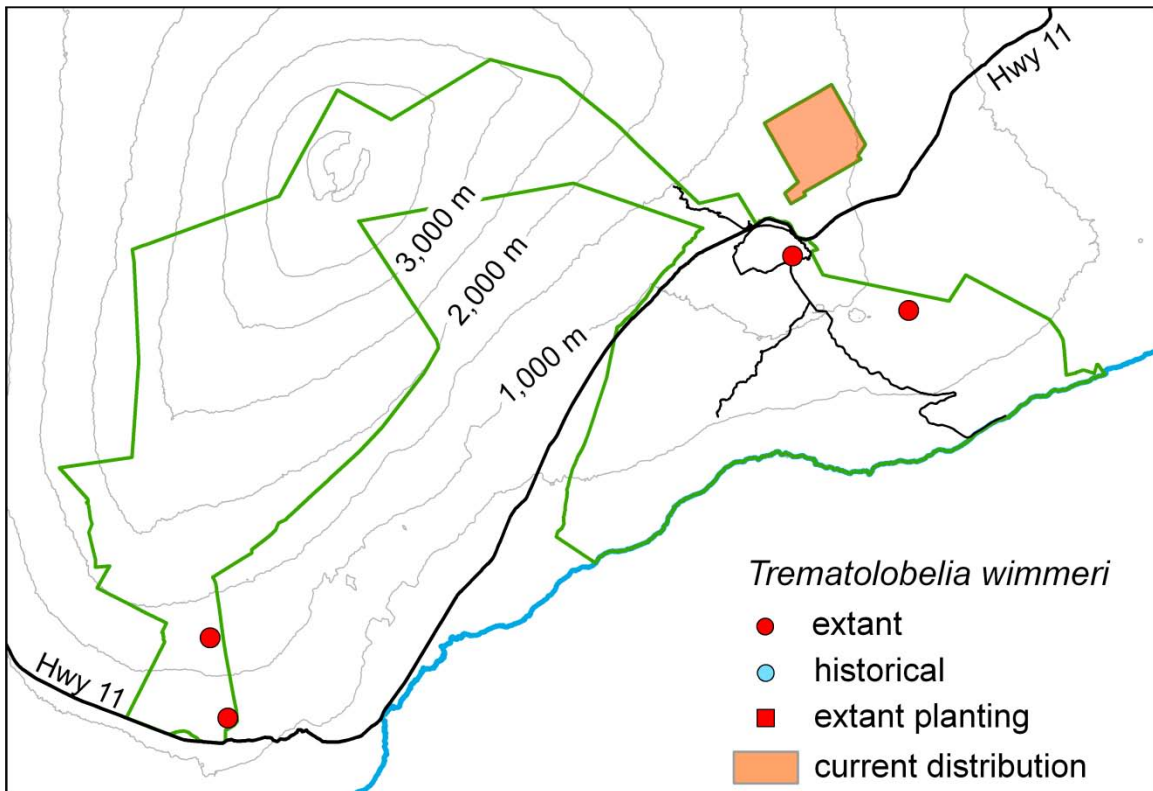
SIMILAR SPECIES: The endangered *Cyanea platyphylla* is similar to *C. tritomantha* in growth form, size, leaf shape, and prickliness, but the two species may be distinguished by the position of their inflorescences. *Cyanea platyphylla* has inflorescences borne in leaf axils rather than crowded beneath the crown of leaves; the species is not known from HAVO. *Cyanea stictophylla*, another rare species, also resembles *C. tritomantha* in prickliness, but its leaves are smaller and shallowly lobed. It is not known from `Ōla`a Forest (see account for that species).

THREATS: Feral pigs are probably the primary threat to this species. Alien slugs and other invertebrates are potential threats. Rats depredate fruits and girdle stems in dry periods.

MANAGEMENT/RESTORATION STRATEGIES: The habitat of `akū in `Ōla`a is free of feral pigs, and invasive alien plants are controlled in several fenced units. The low number of individuals found within HAVO indicates that this species may require active management to persist within the park. In 2001, almost 60 `akū from few founder lines were planted within `Ōla`a Forest split between two sites, and about 30% survived seven to eight years (Belfield *et al.* 2011). It would be prudent to continue propagation using a larger number of founders. `Akū is among the rare species planned for reintroduction to the East Rift Special Ecological Area (S. McDaniel, pers. comm.). Protection of seedlings from slug damage may be necessary to ensure long-term stability of the species. Large-scale control of rats has not yet been tested in park wet forests but would likely benefit this species.

REMARKS: Observations of `akū in the lower East Rift of Kīlauea outside the park (Lamoureux and Char 1985) and reports of prickly *Cyanea* sp. in a kīpuka near Pu`u `Ō`ō destroyed by lava (P. Higashino, pers. comm.) suggest that this species may also have been a component of rain forests in the East Rift SEA.

CULTURAL USES/ETHNOBOTANY: The leaves of this species were cooked and eaten by Hawaiians in the past (Hillebrand 1888).



Koli`i, *Trematolobelia wimmeri*

Photos: Thomas Belfield, PCSU/NPS, HAVO, plant and flowers; Jennifer Johansen, USGS, PIERC, fruit

COMMON NAME: **Koli`i, Wimmer's koli`i**

SCIENTIFIC NAME: *Trematolobelia wimmeri*

FAMILY: Campanulaceae (Bellflower Family), Subfamily Lobelioideae (Lobelia)

SYNONYMS: *Trematolobelia grandifolia*, *T. lustralis*, *T. macrostachys* var. *grandifolia*, *T. kohalaensis*, *T. rockii* var. *hawaiiensis*

FEDERAL AND STATE STATUS: Species of Concern, formerly a Candidate

DESCRIPTION: Unbranched shrub with soft wood, 1–4 m tall, stem densely pubescent. Leaves bright green, paler on undersides, narrowly oblong, oblanceolate, or linear, 13–44 cm long and 1.4–4 cm wide, many times longer than wide; margins with small, thickened teeth; sessile or with winged petiole 2–5 cm long. Flowers borne in a large terminal inflorescence composed of four to eight horizontal branches; branches 12–60 cm long, densely pubescent; each with 10–30 flowers on stalks 16–42 mm long, calyx green with five erect, triangular, lanceolate or oblong lobes 5–9 mm long; corolla yellowish-green or white, sometimes streaked with pink, 54–67 mm long, with a curved tube and five lobes, three lobes grouped together; staminal column 5–6 cm long, pubescent at apex, anthers with tufts of white hairs; style with two-lobed stigma. Fruits are fleshy, nearly globose capsules with 10 ribs, 12–20 mm in diameter when fresh; the outer wall decomposes with maturity and forms pores through which seeds disperse. Seeds yellow to brown, compressed, winged, 1.3–1.7 mm long (Lammers 2009). Phenology: Flowers September–November (Lammers 2009); fruits winter, based on specimens in HAVO Herbarium.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to windward Hawai`i Island between 610 and 1,400 m elevation (2,000–4,590 ft); **distributed from Kohala Mountain to Kīlauea**, found in North Kohala, South Hilo, Puna, and Ka`ū Districts (Lammers 2009). **Recently documented on southeastern Mauna Loa in Ka`ū District (Benitez *et al.* 2008).**

HAVO DISTRIBUTION: `Ōla`a Forest in all fenced units and the unfenced kīpuka of koa in the southeast (Pratt and Abbott 1997), probably throughout `Ōla`a; Kīlauea Caldera rim rain forest; East Rift Special Ecological Area (SEA) on Kāne Nui o Hamo. **Recently found at Kahuku Unit in a pit crater (Benitez *et al.* 2008) and in the lower central region (A. McChristian, pers. comm.).**

HABITAT: This rare lobelioid is restricted to montane wet forest, where it is often seen in light gaps or exposed sites, such as cliffs and bog margins. It is typically epiphytic on logs and tree ferns in closed wet `ōhi`a lehua/hapu`u forest.

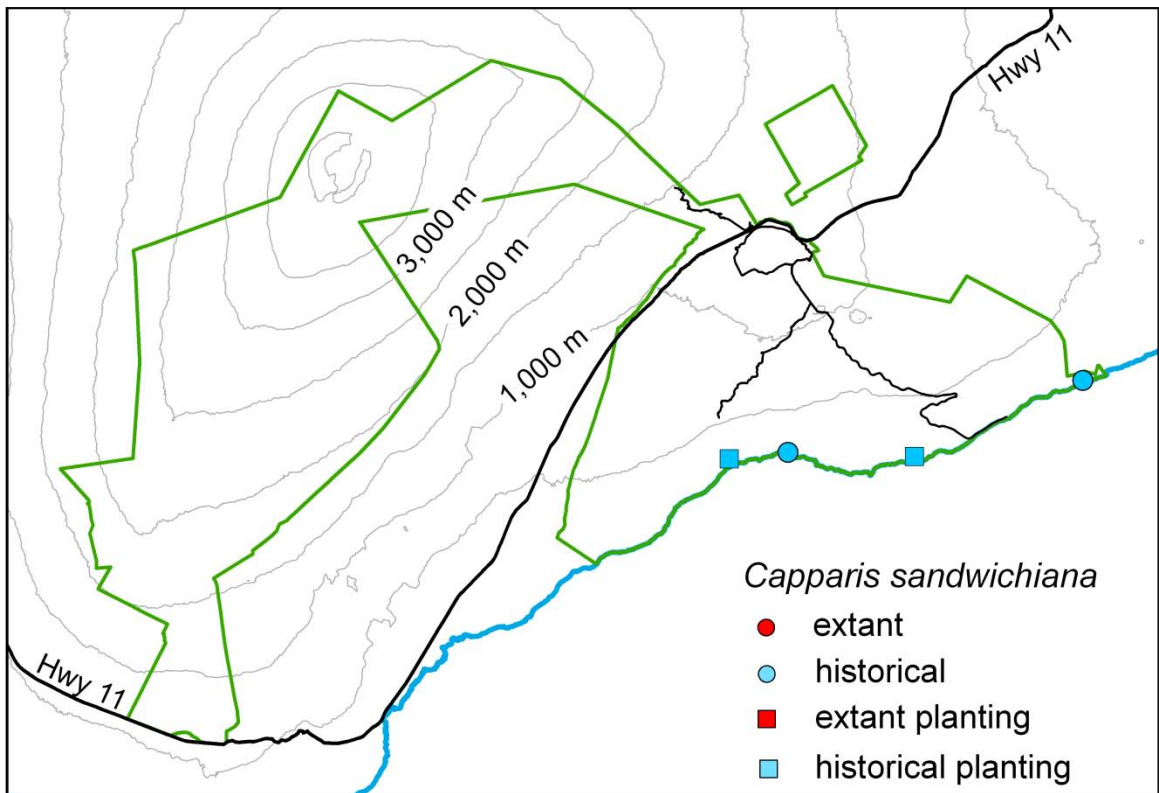
SIMILAR SPECIES: When sterile, koli`i resembles `ōhā or *Clermontia*, but may be distinguished by its single stem and very long, narrow leaves, widest near the tip. When flowering or fruiting, the complex inflorescence and dry fruits with porous walls are unmistakable.

THREATS: Feral pigs are the most serious threat to the habitat of this species. Rats may girdle stems during dry weather, and several alien slug species may damage seedlings and seed capsules.

MANAGEMENT/RESTORATION STRATEGIES: Most of the known habitat of koli`i in HAVO is protected in **pig-free enclosures, which are managed to control the most invasive alien plants. The `Ōla`a trench also supports koli`i (Waite and Pratt 2007) and is targeted for fencing. Plantings are planned for the East Rift and Nāhuku Special Ecological Areas (Loh 2008a). This species will be restored to protected wet forest sites at Kahuku Unit (McDaniel *et al.* 2008). Feasibility of rat and slug control has not been studied.**

REMARKS: Plants of this genus are relatively short-lived (four to eight years) and die after flowering and fruiting (St. John 1982). Formerly known from few localities, this koli`i is widespread and appears to be secure within protected areas of HAVO. The species *T. wimmeri* was recently resurrected and distinguished from *T. grandifolia* by Lammers (2009).

CULTURAL USES/ETHNOBOTANY: None known.



Pua pilo, Maiapilo, *Capparis sandwichiana*
Photo: David Benitez, NPS, HAVO

COMMON NAME: **Pua pilo, Maiapilo**

SCIENTIFIC NAME: *Capparis sandwichiana*

FAMILY: Capparaceae (Caper Family); recently transferred to Brassicaceae, Mustard Family (Wagner and Herbst 2003)

SYNONYMS: *C. sandwichiana* var. *zoharyi*, *C. spinosa* var. *mariana*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Shrub, often sprawling and large. Leaves fleshy, alternate, entire; blade ovate to elliptic, 2–6 cm long and 2–5 cm wide, with blunt or notched (emarginate) tip, petioles 1–4 cm long. Flowers opening in evening; calyx irregular, made up of two pairs of sepals; petals four, white, fading to pink; stamens numerous and exserted; female part of flower stalked, extending beyond the stamens. Fruit an ellipsoid berry 4–5 cm, orange when ripe. Seeds dark brown to gray, asymmetrical, embedded in foul-smelling orange flesh (Wagner *et al.* 1999). Phenology: Flowers open at night (St. John 1965). Flowers are most abundant in spring and summer (Culliney and Kobele 1999), but some may be seen throughout the year.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Coastlines of all the main Hawaiian Islands, as well as Midway, Pearl and Hermes Atoll, and Laysan of the Northwest Hawaiian Islands, to an elevation of 100 m (330 ft). On Hawai`i Island, pua pilo is most frequently seen on shorelines and dry lava fields of the Kona districts.

HAVO DISTRIBUTION: Formerly on Keaoi Island, offshore of Halapē, and at low elevation near the eastern park boundary. Extirpated from Keaoi in 1975, when the island sank following a large earthquake. The eastern boundary site was covered by lava flows from the Pu`u `Ō`ō eruption in the 1980s. Recent plantings at Kālu`e and Kahue did not persist. Likely extirpated from HAVO.

HABITAT: Rocky coastlines and dry coastal lowlands.

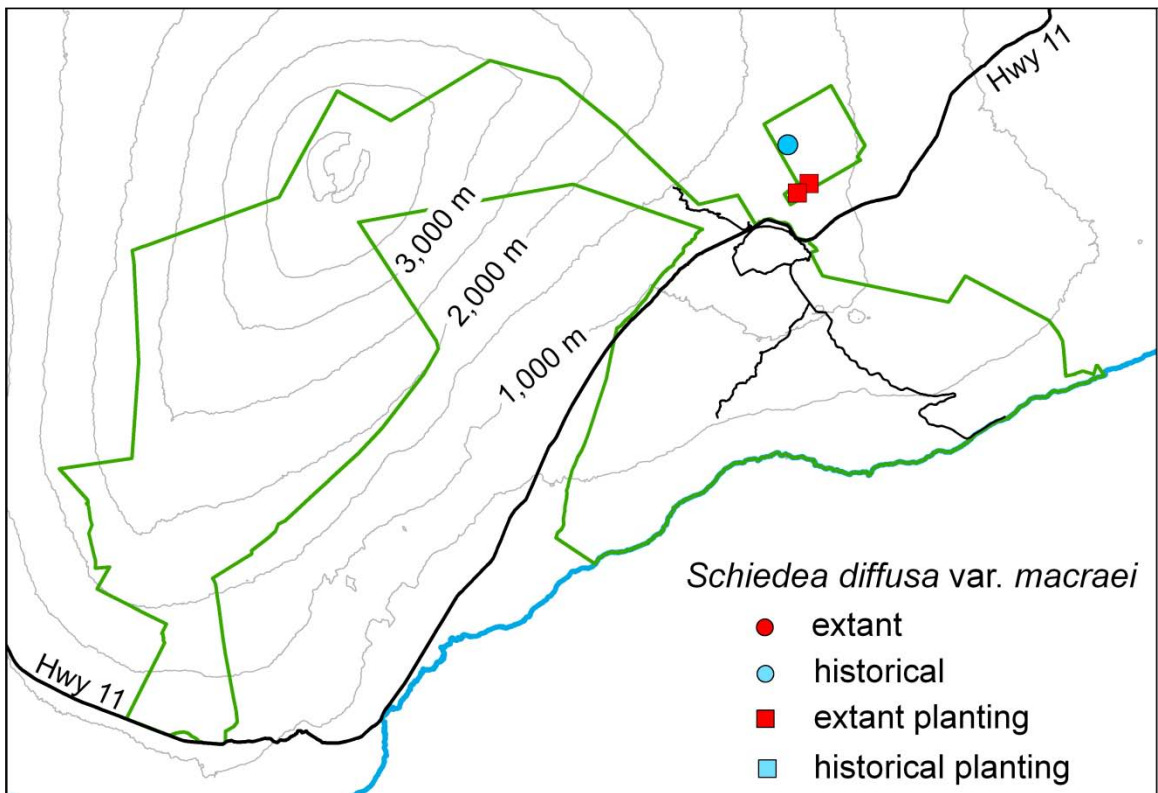
SIMILAR SPECIES: The only related species in Hawai`i are an extinct native spider flower (honohino or *Cleome spinosa*) of Ni`ihau, O`ahu, and Maui, and an alien herb that does not occur within the park (wild spider flower or *Cleome gynandra*). No alien shrubs bear a strong resemblance to pua pilo.

THREATS: In addition to the natural perturbations of lava flows, tidal waves, and coastal subsidence, grazing cattle and feral goats are potential threats to this species. Rats, alien birds, and alien insects may be seed predators of pua pilo. Culliney and Koebele (1999) reported that plants are attacked by caterpillars, slugs, snails, and rodents. Alien grasses that infest the coastal lowlands may interfere with seedling recruitment and increase the threat of wildfire (Smith 1985, **D'Antonio and Vitousek** 1992).

MANAGEMENT/RESTORATION STRATEGIES: The HAVO lowlands are free of feral goats, and highly invasive fountain grass is controlled. Propagation material was collected from the population of pua pilo nearest the park (Kamehame), and a few plants (<10) were introduced at the coastal restoration sites of **Kālu`e and Kahue, but they did not survive a year (Belfield *et al.* 2011)**. Additional efforts may be required to restore this species to coastal sites at HAVO. Research into methods to control rats and alien invertebrates may be useful.

REMARKS: This species is similar to the Pacific caper bush (*C. cordifolia*), which is not found in Hawai`i, and some botanists think pua pilo should be considered part of this widespread species (Whistler 1992, Wagner *et al.* 1999). Such a taxonomic transfer would make future listing as a threatened species very unlikely.

CULTURAL USES/ETHNOBOTANY: The flowers are beautiful, but foul smelling, particularly when enclosed indoors, and thus are rarely used for ornament. The fruits of pua pilo were used in Hawaiian medicine to treat sprains and broken bones (St. John 1965).



Macrae's spreading *Schiedea*, *Schiedea diffusa* subsp. *macraei*
Photo: Linda Pratt, USGS, PIERC

COMMON NAME: **Macrae's spreading schiedea**
SCIENTIFIC NAME: *Schiedea diffusa* subsp. *macraei*
FAMILY: Caryophyllaceae (Pink Family)
SYNONYMS: *Schiedea diffusa* var. *angustifolia*, *S. hawaiiensis*
FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Large vine with slender stems, woody at base. Leaves opposite, lanceolate to ovate, 4–12 cm long and 1.5–4 cm wide, only one vein or nerve visible, apex pointed, base rounded, margins lacking teeth, petioles short, <0.7 cm long. Flowers borne in large, loose inflorescences, 10–50 cm long, individual flower stalks 8–15 mm long, enlarging to 20–40 mm long when fruit are mature. Flowers small; five purple to green sepals, ovate, 4.5–7 mm long, keeled, often with small glandular hairs; petals absent; stamens 10 with filaments 5–9 mm long; styles three to five. Fruits are tiny ovoid capsules, 5–7 mm long, opening when mature to expose numerous smooth, black seeds, almost round, compressed, about 1 mm long (Wagner *et al.* 1999). Phenology: Unknown, but specimens in the HAVO Herbarium bore fruits in summer and fall (July–October).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Subspecies *macraei* is endemic to Hawai`i Island, where it persists only in **the Kohala Mountains and `Ōla`a Forest** between 915 and 1,160 m (3,000–3,800 ft) elevation. A different subspecies (subsp. *diffusa*) occurs on East Moloka`i and East Maui (Wagner *et al.* 1999).

HAVO DISTRIBUTION: `Ōla`a Forest, known from a single site on the eastern edge of the Ag Unit enclosure near 1,200 m (3,940 ft) elevation. The species had not been seen on Hawai`i Island in more than 70 years when one **plant was discovered in `Ōla`a Forest in 1985 (Wagner *et al.* 1999)**. This **natural plant in `Ōla`a may have died, as it could not be found during a search in 2008**. **Macrae's spreading schiedea** has also been **planted in the `Ōla`a Koa Unit and Small Tract**.

HABITAT: Montane wet forest; in HAVO the rare vine was observed in `ōhi`a lehua/hāpu`u forest at slightly higher elevation than the range listed by Wagner *et al.* (1999).

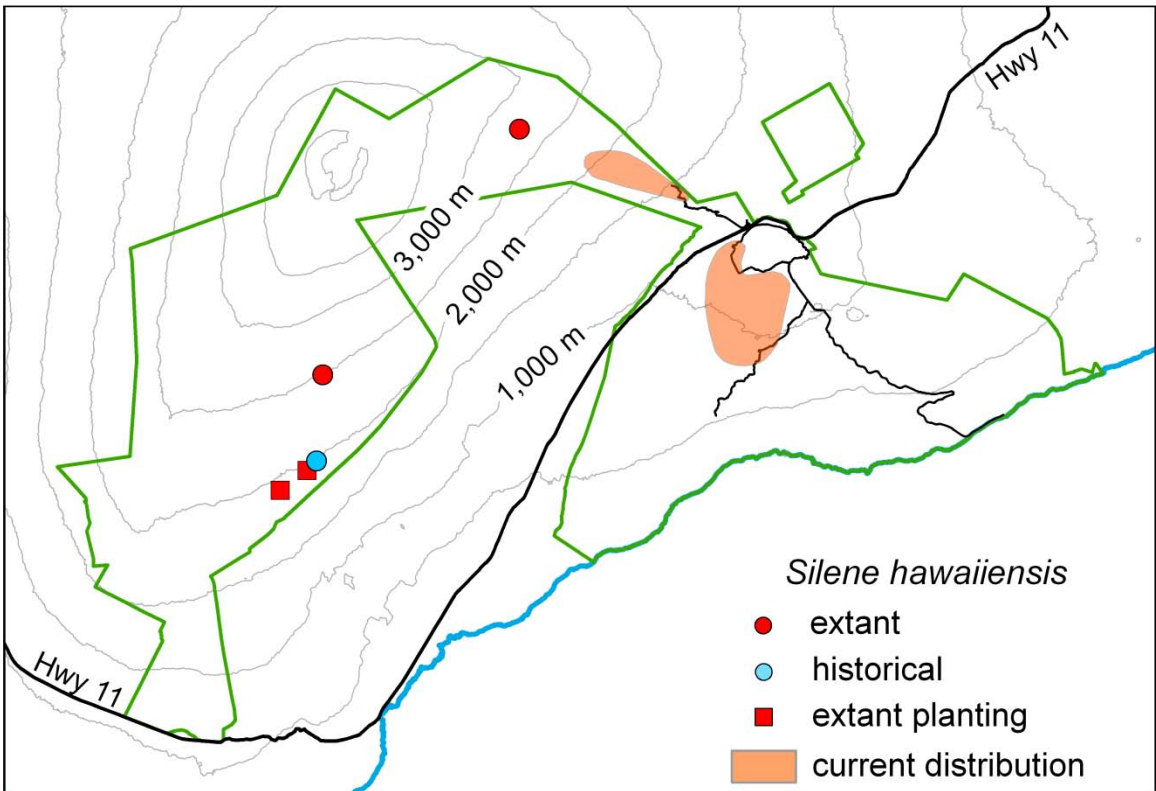
SIMILAR SPECIES: There are no other *Schiedea* species in HAVO, but the vine bears a very superficial resemblance to other rain forest shrubs and vines, such as *Kadua centranthoides* (formerly *Hedyotis*) and maile (*Alyxia stellata*). *Kadua* has very thick, shiny, opposite leaves that are often purple-tinged and have prominent stipules. When fertile, *K. centranthoides* has conspicuous greenish-white, four-parted flowers and distinctive boat-shaped capsules. Maile may be distinguished from *Schiedea* by its fragrant leaves in whorls of three, milky sap, and yellow, tubular flowers.

THREATS: Unknown. Feral pigs may disturb the understory of unprotected rain forests. Alien invertebrates, such as slugs, may threaten this species.

MANAGEMENT/RESTORATION STRATEGIES: The unit of `Ōla`a Forest in which *Schiedea diffusa* occurs has been protected from feral pigs since 1986, and the unit is slated for alien plant control to reduce or remove banana poka, yellow Himalayan raspberry, and kāhili ginger. *Schiedea diffusa* was recently (2003) propagated, and more than 130 plants were distributed between the Small Tract and Koa Unit of `Ōla`a Forest. **Survival** of plantings was poor (<10%) after six years (Belfield *et al.* 2011). More plantings may be necessary to restore a population of this species. Studies of the impacts of slugs on seedlings may be informative.

REMARKS: The *Schiedea* of Hawai`i Island has recently been recognized as a subspecies distinct from that of Maui and Moloka`i.

CULTURAL USES/ETHNOBOTANY: None known.



Hawaiian catchfly, *Silene hawaiiensis*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Hawaiian catchfly**

SCIENTIFIC NAME: *Silene hawaiiensis*

FAMILY: Caryophyllaceae (Pink Family)

SYNONYMS: *Silene struthioloides* var. *gracilis*

FEDERAL AND STATE STATUS: Threatened Species, listed in 1994

DESCRIPTION: Shrub to 1 m in height with brittle, ascending branches. Leaves slender and awl-shaped, 6–15 mm long and <1 mm wide, curved, with sticky hairs, particularly on margins and at base. Flowers in hairy, paniculate cymes, flower stalks 3–6 mm long; calyx purple-tinged, five-toothed, 11–14 mm long, hairy, particularly on margins; corolla with five clawed petals, toothed at apex, with a two-lobed appendage at base, petals maroon on outside, greenish-white on inside and top, 8–10 mm long; stamens 10, 5 mm long, within the corolla; styles three. Fruits are oblong-ovoid capsules, 6.5–7 mm long, straw-colored when mature. Seeds are tiny, pale brown, patterned with minute projections (Wagner *et al.* 1999). Phenology: Flowers mostly in the summer and fall; dry fruit capsules persist throughout the year.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island between 900 and 3,050 m (2,950–10,000 ft) elevation; distributed in North Kona on the slopes of Hualālai, Hāmākua District on the western slopes of Mauna Kea, along the Saddle Road, on several slopes of Mauna Loa, and on Kīlauea.

HAVO DISTRIBUTION: Kīlauea Caldera edges, south and west into the Ka`ū Desert (900–1,200 m [2,953–3,937 ft] elevation); Mauna Loa Strip at 1,525–2,135 m (5,000–7,000 ft) elevation, occasionally at higher elevation. Found in Kahuku at a site in the eastern subalpine zone of the unit and formerly in the original Ka`ū silversword exclosure. Also planted in subalpine exclosures at Kahuku Unit.

HABITAT: Dry ash fields and lava flows; in HAVO, populations occur in montane vegetation of very scattered native shrubs on Kīlauea and subalpine shrubland on Mauna Loa. Old flow channels are a favored habitat in the Mauna Loa Special Ecological Area (SEA).

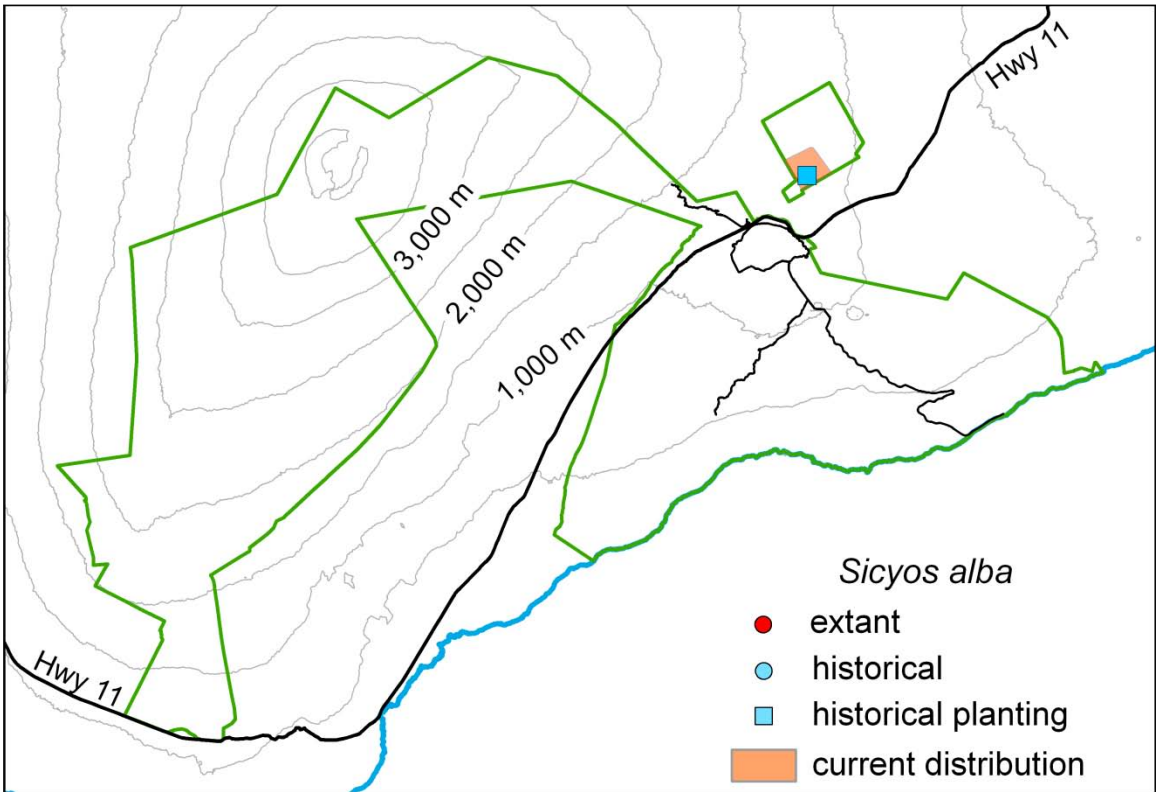
SIMILAR SPECIES: *Silene struthioloides*, found on Mauna Kea, is of similar appearance, but *Silene hawaiiensis* may be distinguished by its curved leaves covered with sticky hairs. Westerbergh and Saura (1994) found significant genetic differences between the two species.

THREATS: Feral goats, sheep, pigs, and mouflon sheep are serious threats to Hawaiian catchfly in unprotected areas. Within HAVO, mouflon sheep have greatly reduced catchfly populations. Hawaiian catchfly may resprout after browsing, but repeated browsing prevents reproduction and may kill plants (Belfield and Pratt 2002). Drought may be a natural limiting factor, and heavy rains may lead to losses from erosional deposition in the Ka`ū Desert.

MANAGEMENT/RESTORATION STRATEGIES: Most of the known plants of Hawaiian catchfly on Mauna Loa are contained within the fenced upper unit of the Mauna Loa SEA, where they are protected from grazing cattle, feral goats, and pigs. Mouflon sheep recently invaded the park from adjacent lands, and great effort was required to rid the Mauna Loa Strip of these animals in 2000. The Hawaiian catchfly population of Kīlauea Caldera and the Ka`ū Desert is not threatened by feral animals and appears to be thriving. Plants in these areas require only protection from four-wheel drive vehicles to minimize disturbance to the habitat. Recently (2006–2008) >100 plants were placed in two silversword exclosures at Kahuku Unit. This species is a candidate for restoration to additional protected sites at Kahuku.

REMARKS: This threatened species appeared to be increasing throughout the park before a prolonged drought in 1997–98 and the invasion of the Mauna Loa SEA by mouflon sheep. One population near 1,710 m elevation (5,600 ft) lost more than 70% of its plants in five years, and a second population decreased by more than 50% in 1998–2000 (Belfield and Pratt 2002).

CULTURAL USES/ETHNOBOTANY: None known.



Ānunu, White Ānunu, *Sicyos alba*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **`Ānunu, White `ānunu**

SCIENTIFIC NAME: *Sicyos alba*

FAMILY: Cucurbitaceae (Gourd Family)

SYNONYMS: *Sarx alba*, *Sicyos cucumerinus* var. B

FEDERAL AND STATE STATUS: Endangered Species, listed in 1996

DESCRIPTION: Vine, reported to be annual, but large vines are perennial and periodically die back to base (L. Pratt, pers. obs.). Stems are covered with short hairs and are black-spotted. Tendrils are two-branched in leaf axils. Leaves alternate, large and fleshy, broadly ovate-cordate, 7–11 cm long and 9–12 cm wide, entire or shallowly three- to five-lobed; margins coarsely toothed. Juvenile leaves often deeply lobed. Flowers unisexual, on same plant, borne in separate inflorescences; male flowers in panicle inflorescences 3–7 cm long on stalks 2.5–4 cm long; flower stalks 2–4 mm long, corolla white and five-lobed, ca. 2 mm long, dotted with glands, three stamens fused into a column with anthers touching; female flowers two to eight in congested heads on an inflorescence stalk 1–3.5 cm long, corolla white, with four lobes ca. 2 mm long, stigma with two lobes, 1 mm long. Fruits fleshy, white to green, ellipsoid in shape, ca. 30 mm long and 10 mm wide. Seed one per fruit, 13 mm long (St. John 1978b, Wagner *et al.* 1999). Phenology: Flowers observed throughout year; fruits present all seasons except summer.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island, where it is currently known from only three **sites on the windward slopes of Mauna Loa and Kīlauea between 1,000 and 1,600 m (3,281–5,249 ft) elevation (Wagner *et al.* 1999): Pu`u Maka`ala Natural Area Reserve, `Ōla`a Forest Reserve, and `Ōla`a Forest. This species was collected on Mauna Kea in the 1800s (St. John 1978b).**

HAVO DISTRIBUTION: `Ōla`a Forest, Koa Unit; at least four groups of `ānunu are found in the southwestern corner of the enclosure, and other nearby sites supported white `ānunu in the recent past (VanDeMark *et al.* 2010).

HABITAT: Montane wet forest of `ōhi`a lehua and hāpu`u near 1,220 m (4,000 ft) elevation.

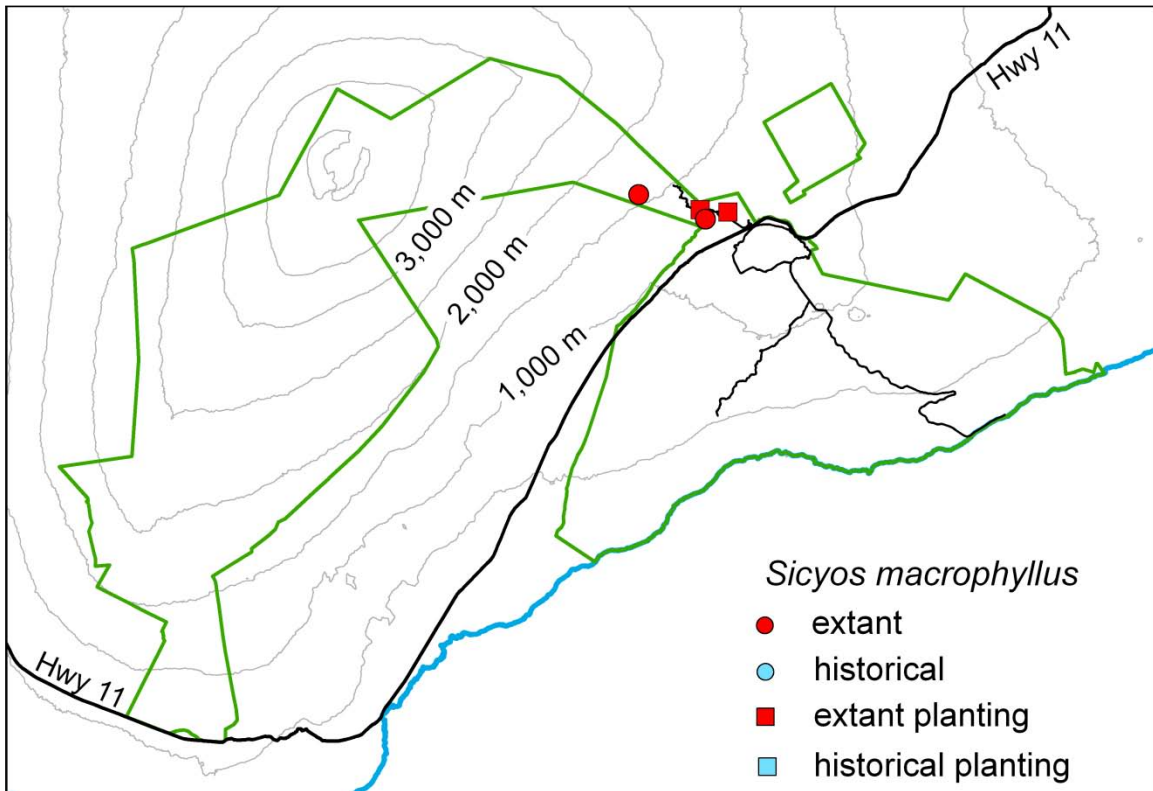
SIMILAR SPECIES: Many of the native species of *Sicyos* are similar vegetatively; no other species grow in `Ōla`a Forest. **The chayote or pipinella (*Sechium edule*), sometimes grown in Hawai`i as a vegetable, is naturalized along Wright Road near `Ōla`a. Chayote may be distinguished from *Sicyos alba* by its three- to five-parted tendrils, its large leaves with three to seven triangular lobes, and its large, green, pear-shaped, edible fruits. `Ānunu may also be confused with sweet granadilla (*Passiflora ligularis*), an alien passionflower vine seen occasionally in `Ōla`a Forest. However, sweet granadilla has glossy, heart-shaped leaves with entire margins and showy flowers with white and purple sepals, petals, and corona.**

THREATS: Feral pigs and alien plants are likely the greatest threats to this fleshy vine (U.S. Fish and Wildlife Service 1998c). Rats are implicated as seed predators (VanDeMark *et al.* 2010). Pollinators are unknown and seedlings may be vulnerable to alien slugs.

MANAGEMENT/RESTORATION STRATEGIES: The Koa Unit of `Ōla`a Forest has been pig-free since 1995, and the most invasive plant species are controlled in the western section near Wright Road. Several seedlings were recently planted at a site in the protected Koa Unit, but plants died after less than two years (VanDeMark *et al.* 2010). The feasibility of rat or slug control has not been studied at scattered groups of rare plants like `ānunu.

REMARKS: This species was discovered within the `Ōla`a Forest of HAVO in 1975 (Jacobi and Warshauer 1975) and 1985 (T. Tunison, pers. comm.). Since protection of the Koa Unit and removal of feral pigs, this `ānunu has appeared in several sites (Pratt and Abbott 1997), and the presence of juveniles and seedlings indicates at least a low level of successful reproduction.

CULTURAL USES/ETHNOBOTANY: None known.



`Ānunu, Large-leaved `ānunu, *Sicyos macrophyllus*

Photos: Linda Pratt, USGS, PIERC; Thomas Belfield, PCSU/NPS, HAVO, juvenile leaves on right

COMMON NAME: **`Ānunu, Large-leaved `ānunu**
SCIENTIFIC NAME: *Sicyos macrophyllus*
FAMILY: Cucurbitaceae (Gourd Family)
SYNONYMS: *Sicyocarya macrophylla*
FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: Vine, perennial, periodically dying back to base. Stems to 15 m long and 4 cm in diameter; sparsely hairy and black-spotted. Tendrils are two-branched in leaf axils. Leaves alternate, large and fleshy, broadly ovate-cordate, 7–25 cm long and 6–26 cm wide, shallowly to deeply three- to five-lobed; margins with small teeth; upper leaf surface hairless; lower surface densely hairy; petioles 2.5–7 cm long. Flowers unisexual on same plant, borne in separate inflorescences; male flowers in hairy panicle inflorescences 8–25 cm long on stalks 6–20 cm long; flower stalks 3–10 mm long, with glandular hairs; corolla greenish-yellow and five-lobed, ca. 4–5 mm diameter, three stamens fused into a column with anthers touching; female flowers two to six in congested heads on a stalk 2–8 cm long; base of flower spindle-shaped (fusiform), 7–12 mm long, ribbed, hairy; corolla white, with five lobes, stigma with three lobes. Fruits clusters of green, firmly fleshy utricles, each section ovoid, 13–18 mm long and 4–6 mm wide, five- to six-ribbed, beaked, covered with minute hairs. One seed per fruit section (Wagner *et al.* 1999). Phenology: Flowers all seasons except summer; fruits persist all year (Pratt *et al.* 2010).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island; known from windward Kohala, Mauna Kea, and Mauna Loa at 1,200–2,000 m (3,940–6,560 ft) elevation (Wagner *et al.* 1999). Recently found in HAVO and on the leeward slopes of Mauna Loa in South Kona (Hakalau Forest Bird Wildlife Refuge-Kona section) (K. Bio, pers. comm.).

HAVO DISTRIBUTION: **Kīpuka Kī; discovered in 2000 on the eastern side of the kīpuka south of Mauna Loa Road.** A second site at approximately 1,585 m (5,200 ft) elevation on the western side of the Mauna Loa Strip was found in 2005 by volunteers working with Natural Resources Management Division. Planted and persisting **in Kīpuka Puaulu and Kīpuka Kī.**

HABITAT: **Montane mesic forest of koa, māmane, `ōhi`a lehua, and mānele in HAVO; elsewhere this `ānunu** occurs in montane wet forest and subalpine forest (Wagner *et al.* 1999).

SIMILAR SPECIES: Many of the native species of *Sicyos* are similar in appearance and require fruits for positive identification. No other *Sicyos* **grows in the vicinity of Kīpuka Kī, although there is a specimen in the HAVO Herbarium identified as *Sicyos anunu* from the HAVO/Kapāpala Ranch boundary (Fosberg 1966).** The leaves of *S. anunu* are deeply lobed with narrow, sharp-tipped lobes; its large compound fruits are composed of many sharp-**beaked fruit segments. In Kīpuka Kī, large-leaved `ānunu often** grows mixed with koali`awa or morning glory (*Ipomoea indica*), which has entire, heart-shaped leaves and large pink to blue funnel-shaped flowers.

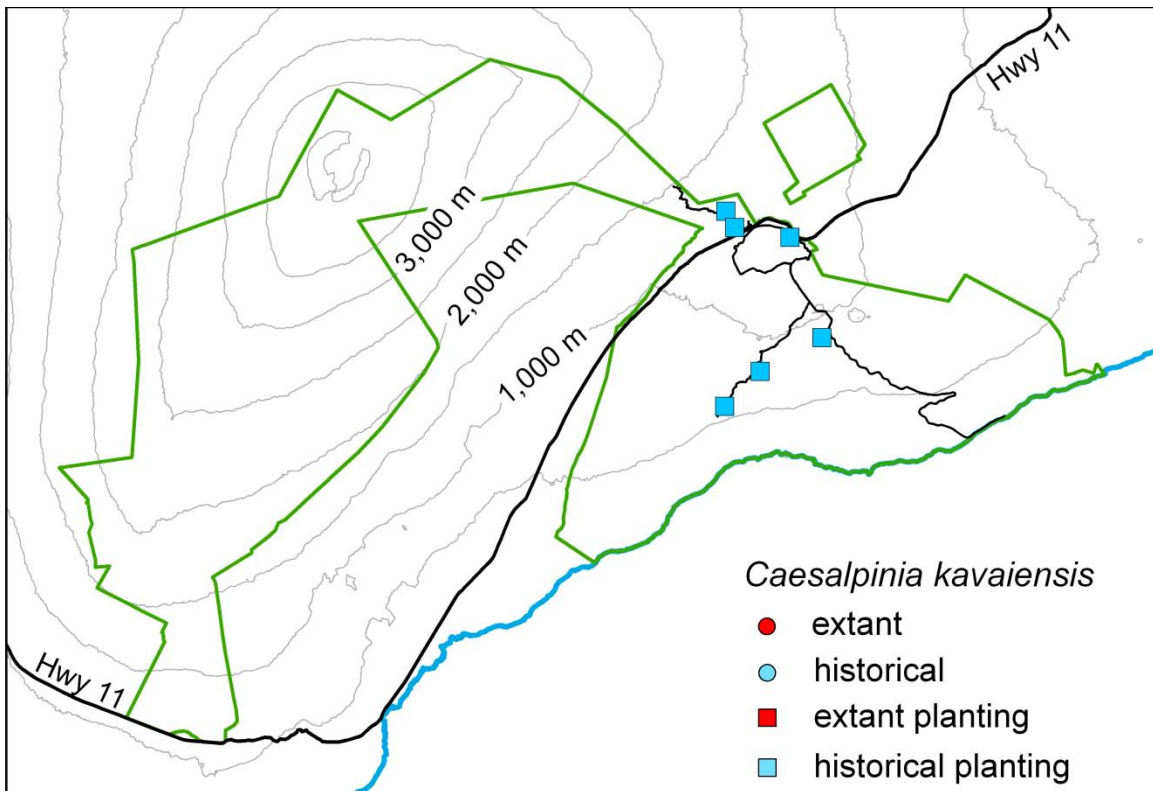
THREATS: Feral ungulates, domestic cattle, fire, and invasive alien plants are potential threats. Rats destroy seeds of this species (Pratt *et al.* 2010).

MANAGEMENT/RESTORATION STRATEGIES: **Kīpuka Kī is free of feral ungulates, and boundaries are fenced against incursions of cattle from adjacent ranches.** Treatment of invasive alien plants is underway. A large central area has been cleared of blackberry, Jerusalem cherry, and meadow ricegrass. **Plantings were recently made at Kīpuka Kī and Kīpuka Puaulu, and more than a third of 18 `ānunu vines** survived 2–3 years (Belfield *et al.* 2011). Rat control has not been attempted for this species.

REMARKS: The recent discovery of large-leaved **`ānunu** at HAVO extended the known range of the species 30 km to the south. This find illustrates the high species diversity of the remnant mesic forest **kīpukas and the need for continued basic rare plant surveys.**

CULTURAL USES/ETHNOBOTANY: None known.

Introduced to HAVO



Uhiuhi, *Caesalpinia kawaiiensis*

Photos: Thomas Belfield, PCSU/NPS, HAVO; Linda Pratt, USGS, PIERC, fruit pods

COMMON NAME: **Uhiuhi**

SCIENTIFIC NAME: *Caesalpinia kawaiensis*

FAMILY: Fabaceae (Pea Family), Subfamily Caesalpinioideae

SYNONYMS: *Mezoneuron kawaiensis*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1986

DESCRIPTION: Tree, of medium stature, to 10 m in height. Bark rough and dark. Leaves bipinnately compound, soft in texture, with one to five pinnae, each with four to eight pairs of leaflets about 3 cm in length. Flowers are borne in terminal racemes and are pink to dark red in color. Fruits are dry pods or legumes, flat and thin in shape, approximately 8 cm long and 5 cm wide, bluish gray when young and pink to gray when mature (Wagner *et al.* 1999). Phenology: Flowers in the winter (Culliney and Koebele 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Uhiuhi was historically known from dry leeward regions of Kaua`i, O`ahu, Maui, and Hawai`i Islands; recently it was discovered on Lāna`i. **Fewer than 80 trees** are thought to exist in the wild (U.S. Fish and Wildlife Service 1994). On Hawai`i Island, the species **occurs in North Kona District, at Pu`uwa`awa`a, Ka`ūpūlehu, and Kealakehe.**

HAVO DISTRIBUTION: Uhiuhi is not native to HAVO, but was planted at several localities between 1924 and 1979. **More than 18 trees were planted among Kīpuka Puaulu, Old Volcano House near park headquarters, Nāmakanī Paio, Kīpuka Nēnē, and Hilina Pali between 1924 and 1958; these had all died** by 1967 (Morris 1967). An additional 125 seedlings were out-planted at upper `Āinahou Ranch in 1974–1979 from material collected at Pu`uwa`awa`a. Surviving plants were removed to arboreta in 1980 (N. Zimmer, unpublished data). Likely no longer present at HAVO.

HABITAT: The natural habitat of this tree is lowland dry forest. In North Kona, trees persist in a dry forest of lapa and kauila that has been invaded by fountain grass and other non-native species.

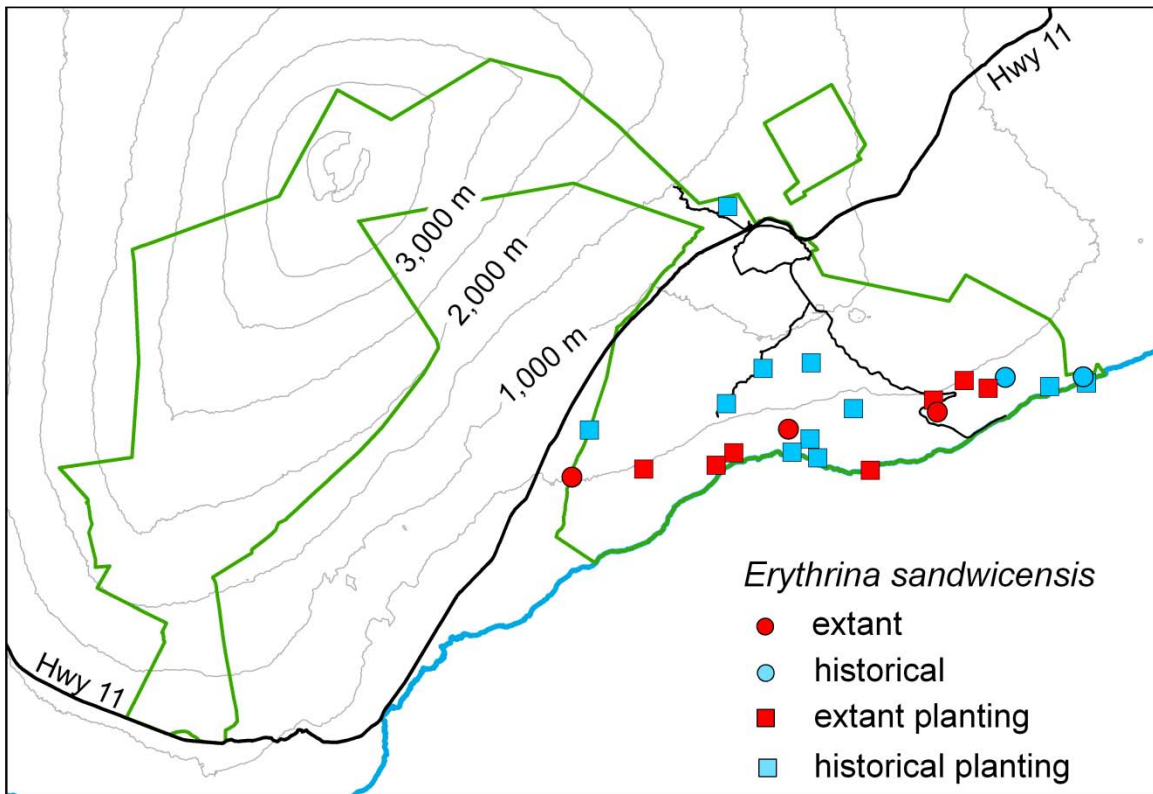
SIMILAR SPECIES: Uhiuhi does not closely resemble other native trees of the pea family; the most similar indigenous tree occurring in the same habitat is kolomona (*Senna gaudichaudii*). Kolomona has once-pinnate compound leaves and yellow flowers. It is more likely that uhiuhi in the sterile condition might be mistaken for non-flowering koa haole (*Leucaena leucocephala*), an invasive shrub native to tropical America now widespread in dry lowland regions of Hawai`i. Koa haole leaves have a greater number of leaflets that are half the size of uhiuhi leaflets.

THREATS: Fire, cattle grazing, and damage from feral goats and mouflon sheep are threats to the tree in its natural habitat. Fountain grass likely interferes with natural regeneration and promotes destructive wildfires in North Kona of Hawai`i Island.

MANAGEMENT/RESTORATION STRATEGIES: This species may not be appropriate to HAVO, an area outside its natural range. Former out-planting sites within the park could be systematically searched to confirm that the tree is no longer extant in HAVO. If any trees persist in the park, they may be of use in a recovery program in North Kona District.

REMARKS: This endangered tree species has been extirpated from most of its range on Kaua`i, O`ahu, **Lāna`i, and Maui, and persists with reproducing populations only at** a site on O`ahu and at three scattered sites in North Kona, Hawai`i Island (U.S. Fish and Wildlife Service 1994). Uhiuhi was planted within HAVO at a time when the park was considered the only protected site for rare trees on the island.

CULTURAL USES/ETHNOBOTANY: The wood of uhiuhi is hard and dense and was used by Hawaiians for fishing implements, spears, digging sticks, kapa (bark cloth) beaters, and sled-runners (Rock 1913).



Wiliwili, *Erythrina sandwicensis*

Photos: Thomas Belfield, PCSU/NPS, HAVO, tree; Betsy Gagne, © Smithsonian Institution Botany Department, flower

COMMON NAME: **Wiliwili**

SCIENTIFIC NAME: *Erythrina sandwicensis*

FAMILY: Fabaceae (Pea Family), Subfamily Faboideae

SYNONYMS: *Erythrina monosperma*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Tree to 15 m tall; bark smooth, papery, reddish-orange; trunk and branches often armed with dull conical prickles. Leaves compound with three leaflets, terminal leaflet deltate, wider than long, 4–10 cm long, 6–15 cm wide, apex and base rounded; lateral leaflets ovate, 4–8 cm long, 4–9 cm wide, with asymmetrical bases. Undersides of leaflets densely covered with whitish, star-shaped hairs. Petiole of terminal leaflet 8–15 cm, with paired glandular appendages below leaflet. Flowers at the tip of stout horizontal inflorescences 10–15 cm long; pea-shaped flowers 4–5 cm long; usually salmon-red to orange, but may be yellow, white, or green; 10 stamens and a slender style extend beyond the petals. Fruit a legume, splitting when mature, constricted between seeds. Seeds 1–3 per pod, red or yellow-orange, 1.5 cm long and 1 cm wide (Wagner *et al.* 1999). Phenology: Flowers and drops leaves in summer.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Found on all the main Hawaiian Islands, including Kaho`olawe and Ni`ihau, on leeward slopes below 600 m (2,000 ft) elevation.

HAVO DISTRIBUTION: Formerly common at Waha`ula and forest above Kamoamo in the eastern coastal lowlands, now destroyed by lava. A few trees persist on pali (cliffs) of the coastal lowlands and at the Great Crack on the western park boundary. **Planted and persisting at Pu`u Kaone, `Āpua Point, Kālu`e, Nāulu Forest, the base of Hōlei Pali near Pali Uli, and in burned sites northeast of the Chain of Craters Road and at Pepeiau.** Formerly planted but no longer present at Kīpuka Puauulu, Kīpuka Nēnē, near `Āinahou, the end of Hilina Pali Road, coastal Halapē, Keauhou, Kamoamo, Waha`ula, and several sites along trails to the coastal lowlands.

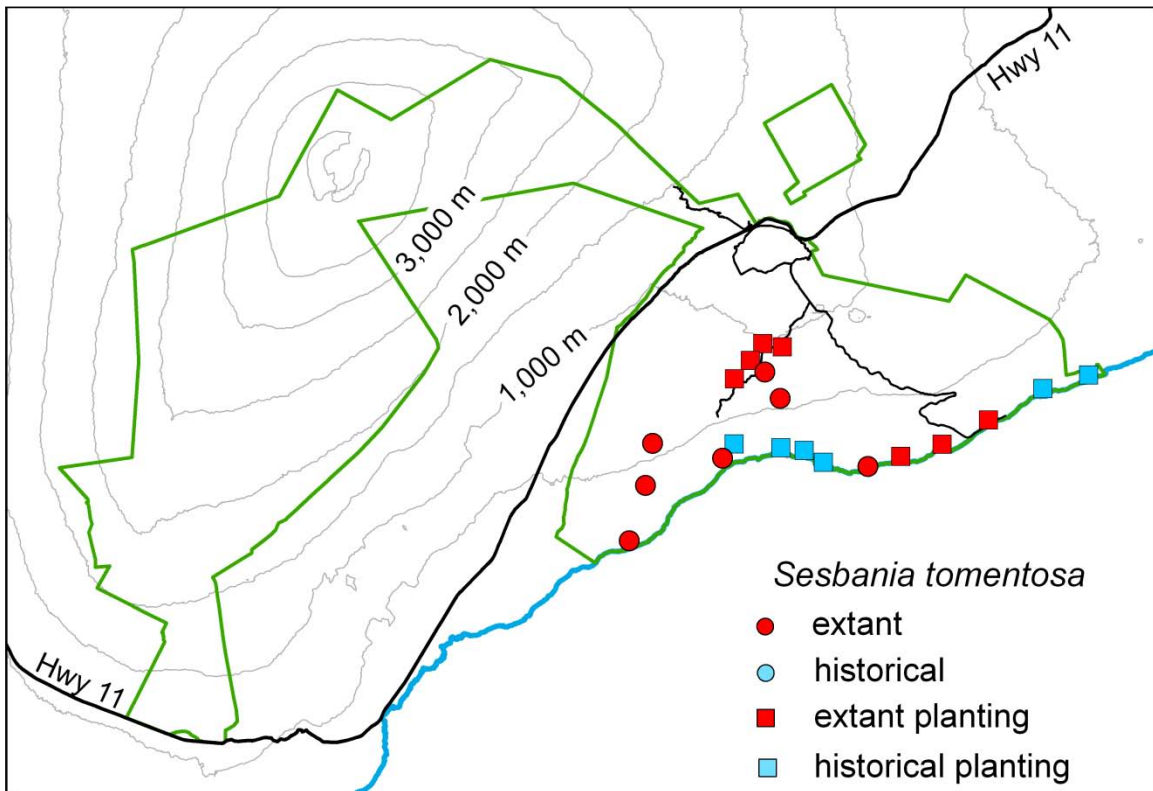
HABITAT: Lowland dry forest and shrubland.

SIMILAR SPECIES: No other similar tree of the Pea Family shares wiliwili habitat. `Ohe makai (*Reynoldsia sandwicensis*) may grow with wiliwili, but its compound leaves have 5–15 shiny green leaflets with toothed margins. Wiliwili may be distinguished from the ornamental Indian coral tree (*Erythrina variegata*) by its flowers, fruits, and leaves. The Indian coral tree flowers in the winter and spring with large red, orange, or white flowers; pods have many (4–13) purple seeds. The leaflets of the coral tree are not hairy and are elliptic or circular (Staples and Herbst 2005).

THREATS: In the past, feral goats were a threat to this tree in its lowland habitat. Fire is a potential threat. The most serious current threat to all wiliwili trees is the *Erythrina* gall wasp that first appeared in Hawai`i in 2005; galls are formed by egg laying and larval feeding, which cause leaf deformities and defoliation (Heu *et al.* 2006). An introduced Bruchid beetle that destroys seeds is also present in Hawai`i but has not been confirmed from HAVO (Medeiros *et al.* 2008).

MANAGEMENT/RESTORATION STRATEGIES: Feral goats have been removed from habitat of wiliwili, and **fires are suppressed.** Past plantings of wiliwili in 1924 at Kīpuka Puauulu, in 1941–1955 at Hilina Pali Road and `Āinahou (Morris 1967), and in the 1970s at the coastal lowlands (N. Zimmer, unpublished data) did not survive. **Planted trees at Pu`u Kaone and `Āpua have persisted for more than 30 years.** In 1998–2005, **>400 trees were planted at Hōlei Pali, Nāulu Forest, and burned sites near Chain of Craters Road.** Initial survival of plantings was good, but trees have been attacked by gall wasps, and only a quarter of **those planted at Nāulu survived** five to six years (Belfield *et al.* 2011). Monitoring of HAVO wiliwili for both the gall wasp and seed-predating beetle is warranted. Gall wasp biocontrol agents were recently released (Environment Hawai`i 2009), and their successful establishment may reduce damage to wiliwili.

CULTURAL USES/ETHNOBOTANY: The soft wood of wiliwili was used for canoe outriggers and surfboards, and the red seeds are still used for lei-making (Rock 1913, Abbott 1992).



`Ōhai, *Sesbania tomentosa*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: `Ōhai

SCIENTIFIC NAME: *Sesbania tomentosa*

FAMILY: Fabaceae (Pea Family), Subfamily Faboideae

SYNONYMS: *Sesbania arborea*, *S. hawaiiensis*, *S. hobdyi*, *S. molokaiensis* f. *arborea*, *S. tomentosa* var. *molokaiensis*; *S. kauensis*, *S. k.* var. *intermedia*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Sprawling shrub or upright to >2 m in height, most parts silky hairy. Leaves pinnately compound with 18–38 leaflets, with stipules at base; leaflets oblong elliptic, 15–38 mm long and 5–18 mm wide, hairy, apex and base rounded. Flowers are two to nine in axillary racemes 1–7 cm long; flower stalks 9–40 mm long, densely hairy; calyx green, 7–12 mm long, hairy, bell-shaped, five-toothed; corolla pea-shaped, orange-red, scarlet, or salmon-pink, with a standard petal and side petals (wings) each 23–45 mm long, and curved keel petal shorter; stamens ten with nine fused into a column; style longer than stamens. Fruits are legumes, 70–230 mm long and 4–6 mm wide, slightly constricted between the seeds. Seeds are olive to brown, oblong, 2–6 mm long (Wagner *et al.* 1999). Phenology: Flowers heavily in the summer and fruits in the fall and winter.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: All main Hawaiian Islands, as well as Necker and Nihoa; reduced to relictual populations on coasts and lowlands to 830 m (2,720 ft) elevation.

HAVO DISTRIBUTION: Six natural **population nodes at `Āpua Point, Kamo`oali`i, Kū`ē`ē, Kīpuka Pepeiau/Kukalau`ula, Hilina Pali, and Kīpuka Nēnē**. Scattered individuals occur at Ka`aha and elsewhere in coastal lowlands. At least 200 `ōhai plants were mapped at HAVO in the mid-1990s (L. Pratt, unpublished data), but the current number is likely lower. A single planted individual (1970s) persists on Chain of Craters Road near Lae`Apuki. Formerly planted at Kamoamoā and Waha`ula; now covered by lava. Plantings at coastal Ka`aha, **Keauhou, Halapē, and Pu`u Kaone did not persist**. Recent plantings at coastal Kahue, Kealakomo, Lae`Apuki, and several Hilina Pali Road sites were marginally successful.

HABITAT: Coastal sites where `ōhai grows in sand and ash pockets over pāhoehoe in coastal vegetation dominated by naupaka kahakai. Also found in coastal lowlands vegetated primarily with native pili and alien grasses and in lowland dry woodlands of `ōhi`a lehua, shrubs, and alien grasses.

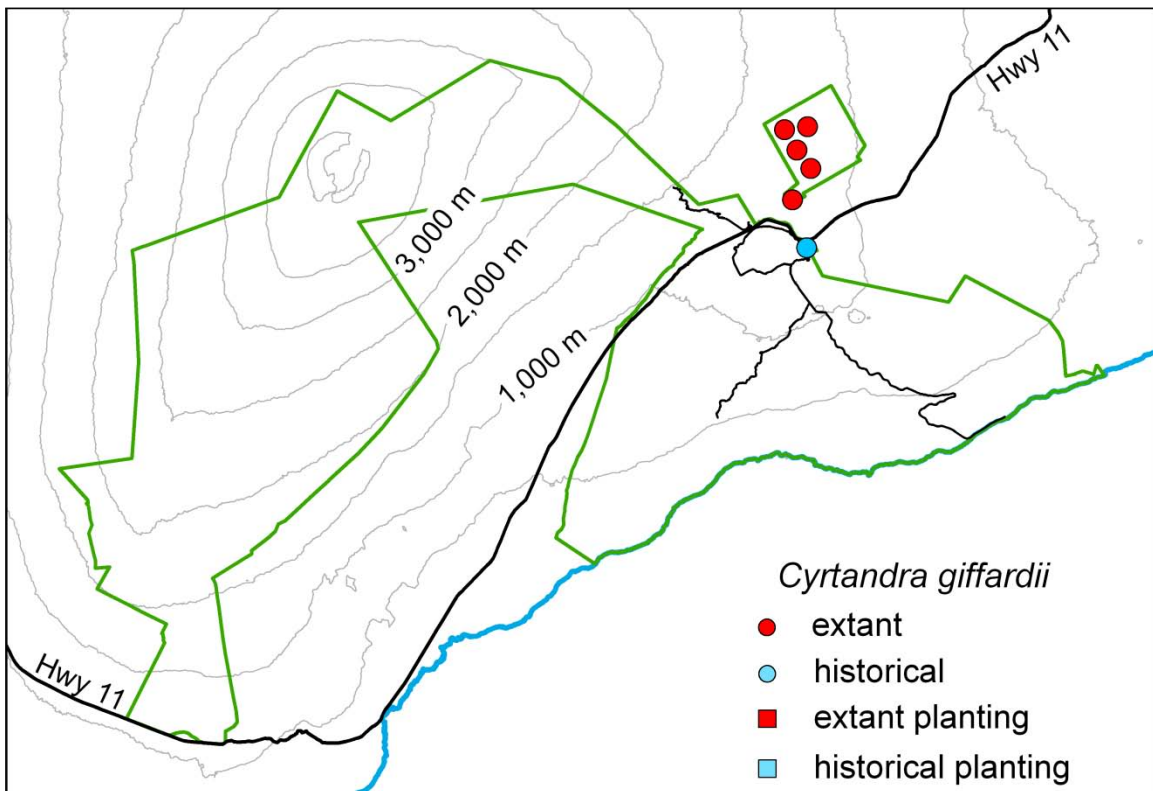
SIMILAR SPECIES: `Ōhai is unmistakable when in flower. Other shrubs in the Pea Family that occur in the same habitat are indigo (*Indigofera suffruticosa*), distinguished by small pinnately compound leaves, tiny pale red flowers, and persistent curled pods; and `auhuhu (*Tephrosia purpurea*), with pinnately compound leaves, white flowers, and twisted pods.

THREATS: Feral goats and fire are major threats to this species. Rats are **seed predators at `ōhai** populations on other islands (Hopper 2002). Alien grasses may compete with seedlings and increase the **likelihood of fires (D'Antonio and Vitousek 1992)**. **Natural pollinators (including several species of yellow-faced bees)** may be reduced or eliminated in parts of the coastal lowlands (Daly and Magnacca 2003).

MANAGEMENT/RESTORATION STRATEGIES: Feral goats have been removed from the coastal lowlands, and wildfires are actively suppressed. The invasive fountain grass is controlled **parkwide**. `Ōhai has been propagated and planted in the past by park managers with little success (N. Zimmer, unpublished data). Recently new plantings were made at sites along Hilina Pali Road (2006), as well as at four coastal sites (1998), but mortality rates were 87–100% at the plantings after two to nine years (Belfield *et al.* 2011, Pratt *et al.* 2011). The feasibility of rat control has not been studied at either natural **populations or plantings of `ōhai in the park**.

REMARKS: Char (1983) recognized three *Sesbania* taxa from HAVO: *S. tomentosa* var. *tomentosa* and *S. kauensis* var. *kauensis* at `Āpua; and *S. kauensis* var. *intermedia* at Kīpuka Nēnē.

CULTURAL USES/ETHNOBOTANY: Flowers possibly used in Hawaiian lei making.



Ha'iwale, Kanawao ke'oke'o, Giffard's ha'iwale, *Cyrtandra giffardii*
 Photos: Linda Pratt, USGS, PIERC

COMMON NAME: **Ha`iwale, Kanawao ke`oke`o, Giffard's ha`iwale**

SCIENTIFIC NAME: *Cyrtandra giffardii*

FAMILY: Gesneriaceae (African violet Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Shrub or small tree to 5 m in height, with brittle stems. Leaves opposite, elliptic, 6–12 cm long and 2.5–4.5 cm wide, upper surface sparsely hairy, lower surface hairless or with brown hairs along the veins, margins with fine forward-pointing teeth (serrulate). Flowers three to five in loose inflorescences with peduncles 25–35 mm long and pedicels 15–30 mm long; calyx cleft to near the base with five narrowly-deltate lobes 3–9 mm long; corolla tubular, white, to 12 mm long, sparsely hairy. Fruits white, ovoid, ca. 1 cm long. Seeds numerous and minute (Wagner *et al.* 1999). Phenology: No distinct seasonal pattern is seen in the production of flowers, but fruits are observed mostly in the fall and winter (VanDeMark *et al.* 2010).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island between 940 and 1,500 m elevation (3,080–4,920 ft), restricted to a few sites on windward Mauna Kea and Mauna Loa, formerly known from Kīlauea (Wagner *et al.* 1999). The species has been documented from Pu`u Maka`ala Natural Area Reserve, adjacent to `Ōla`a Forest.

HAVO DISTRIBUTION: `Ōla`a Forest, primarily in the Koa and Ag units in the southwest of the tract. A few plants have been observed in the Pu`u and New units in the northwest quarter of `Ōla`a and within the Small Tract (Pratt and Abbott 1997). Formerly found on Kīlauea summit.

HABITAT: Montane wet forest of `ōhi`a lehua with an understory of tree ferns.

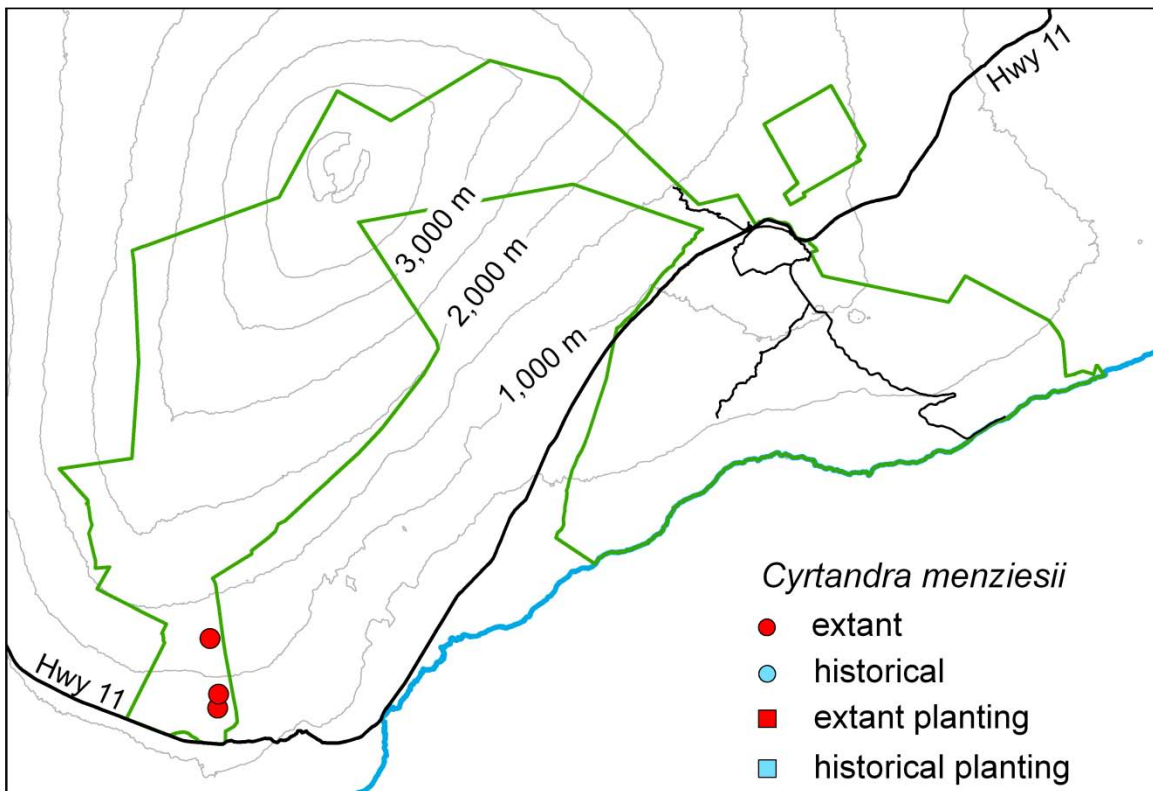
SIMILAR SPECIES: Within `Ōla`a Forest, at least three *Cyrtandra* species and hybrids share the same habitat with *C. giffardii*. The species most closely resembling the endangered ha`iwale is *C. lysiosepala*; this species may be distinguished from *C. giffardii* by its large, pale, leaf-like calyx lobes and dark-green shiny leaves with light undersides. Leaves of *C. lysiosepala* are often borne in whorls of three. In `Ōla`a Forest, *Cyrtandra lysiosepala* is typically a shrub of shorter stature than *C. giffardii*, which achieves the height of a small tree. Hybrids of the two species may be difficult to distinguish from *C. giffardii*.

THREATS: Feral pigs are a threat to Giffard's ha`iwale throughout its range. Invasive alien plants, such as kāhili ginger, banana poka, strawberry guava, and yellow Himalayan raspberry are threats to the integrity of the species' habitat. Pollinators are unknown for this species, and loss of native insects due to predation by yellow jacket wasps is a potential problem.

MANAGEMENT/RESTORATION STRATEGIES: Feral pigs have been removed from four of five management units of the park's `Ōla`a Forest, and invasive alien plants are controlled in western `Ōla`a. Because 90 individuals of Giffard's ha`iwale were mapped in `Ōla`a Forest (Pratt and Abbott 1997) and plants persist in the same areas more than 10 years later (VanDeMark *et al.* 2010), this species seems to be stable within HAVO. However, it is likely that many mapped individuals are actually hybrids. Reproductive success has only recently been monitored within the park, and the rate of seedling recruitment is not known. Further research on pollinators, breeding system, and seedling recruitment is desirable. Planting of vegetatively-propagated Giffard's ha`iwale is planned for Nāhuku (Thurston) Special Ecological Area (S. McDaniel, pers. comm.); this will ensure that plantings are not hybrids.

REMARKS: Rock (1919b) collected Giffard's ha`iwale in forests near the Volcano House in 1911 and 1918. The species has not been seen on Kīlauea since early in the last century and presumably has been lost from the region, except for hybrids in forested pit craters of the East Rift (Belfield 1998). Ha`iwale and kanawao ke`oke`o are generic names for the group.

CULTURAL USES/ETHNOBOTANY: None known.



Ha`iwale, Kanawao ke`oke`o, Menzies' ha`iwale, *Cyrtandra menziesii*
 Photo: W. L. Wagner, © Smithsonian Institution Botany Department

COMMON NAME: **Ha`iwale, Kanawao ke`oke`o, Menzies' ha`iwale**

SCIENTIFIC NAME: *Cyrtandra menziesii*

FAMILY: Gesneriaceae (African violet Family)

SYNONYMS: *Cyrtandra brighami*, *C. menziesii* var. *gaudichaudiana*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Shrub to 5 m in height, usually many-branched with brittle stems. Leaves opposite or in whorls, elliptic to oblanceolate, 10–27 cm long and 3–7 cm wide, upper surface sparsely hairy, lower surface hairless to sparsely hairy along the veins, margins coarsely toothed (serrate). Flowers five to ten in congested inflorescences with stout peduncles 5–20 mm long and slender pedicels 5–22 mm long, elongating in fruit; calyx cleft to near the base with five similar linear lobes; corolla tubular, white, 9–12 mm long, hairy, densely so in bud. Fruits white, almost globose, to 1.6 cm long. Seeds minute (0.2–0.3 mm) (Wagner *et al.* 1999). Phenology: Flowers and fruits are seen in summer at Kahuku (based on specimens in HAVO Herbarium).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i Island endemic found at 530–1,250 m (1,700–4,100 ft) elevation. **Known from North and South Kona and adjacent Ka`ū District.**

HAVO DISTRIBUTION: Kahuku Unit where small populations occur within a large forested pit crater surrounded by pasture and in a crater and associated ravines at Pu`u `Akihi, a hill in the southeastern section of the central pasture.

HABITAT: Lowland or montane mesic to wet forest of `ōhi`a lehua.

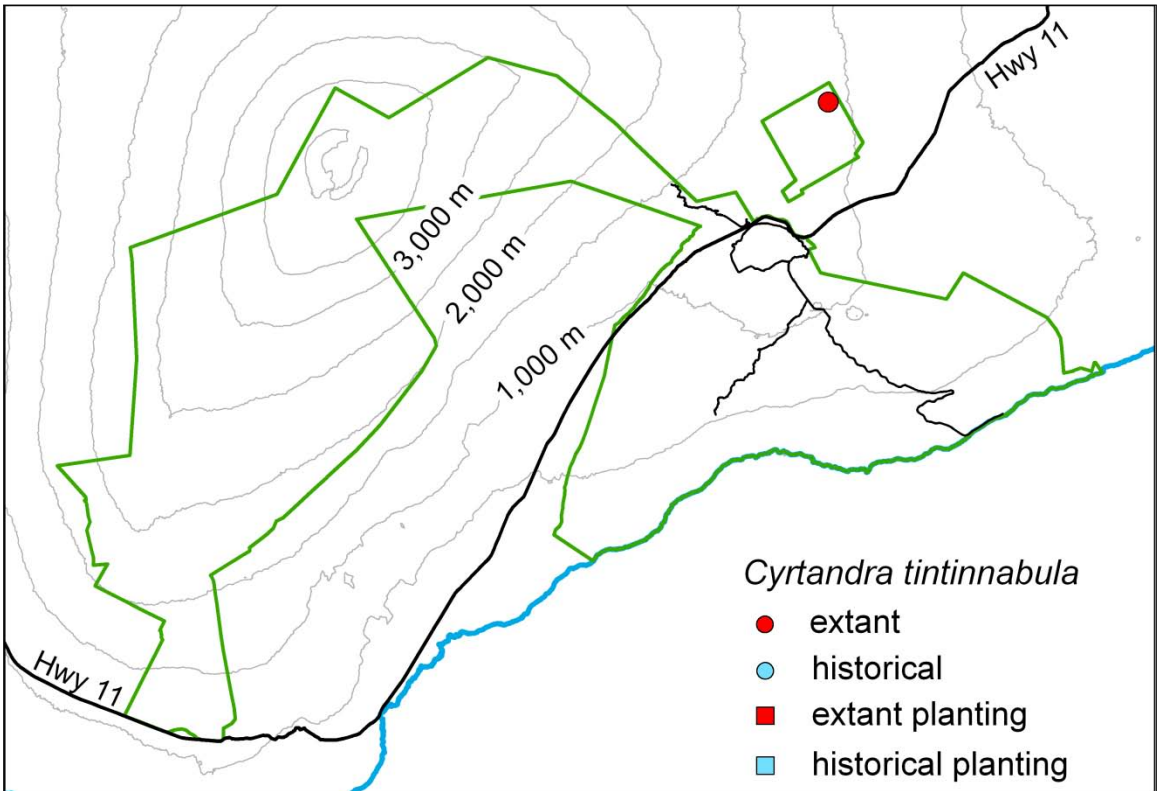
SIMILAR SPECIES: *Cyrtandra lysiosepala* is similar in the sterile condition, but its flowers have distinctive large, pale, leaf-like (foliose) calyx lobes.

THREATS: Ha`iwale shrubs, in general, have weak, brittle stems vulnerable to damage from cattle and **feral ungulates in unprotected habitat. Pollinators are largely unknown and may be lost or limited. Kāhili ginger** was established and spreading in the habitat of this ha`iwale at Kahuku Unit.

MANAGEMENT/RESTORATION STRATEGIES: Protection of currently inhabited sites and potential restoration sites from ungulates will secure the current populations in Kahuku. Removal of cattle is scheduled for 2010, and mouflon sheep are being controlled in the central section of Kahuku (R. Loh, **pers. comm.**). **Recently kāhili ginger was treated within the ravine adjacent to Pu`u `Akihi; alien plant control continues in the habitat of this ha`iwale. Propagation and planting of Menzies' ha`iwale are planned for protected sites at Kahuku Unit (McDaniel *et al.* 2008).** Research into the pollination biology of this species may provide useful information.

REMARKS: This species was not known from HAVO prior to the addition of the Kahuku Unit. Ha`iwale and kanawao ke`oke`o are generic Hawaiian names for plants of this genus.

CULTURAL USES/ETHNOBOTANY: None known.



Ha'iwale, Kanawao ke'oke'o, Bell ha'iwale, *Cyrtandra tintinnabula*
 Photos: Karl Magnacca, University of Hawai'i at Hilo

COMMON NAME: **Ha`iwale, Kanawao ke`oke`o, Bell ha`iwale**

SCIENTIFIC NAME: *Cyrtandra tintinnabula*

FAMILY: Gesneriaceae (African violet Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Shrub 1–2 m tall, with brittle stems. Leaves opposite, broadly elliptic or ovate; 13–26 cm long and 5–12 cm wide; upper surface sparsely hairy, lower surface covered with long soft, yellowish-brown hairs, particularly along the veins; margins with outward-pointing (dentate) or forward-pointing teeth (serrate); tip of leaf long and pointed (acuminate), base of leaf broadly cuneate or truncate, two sides asymmetrical. Flowers three to five in relatively short, open inflorescences arising from leaf axils, with peduncles 10–18 mm long and pedicels 5–15 mm long; inflorescence surrounded by distinctive leaf-like, heart-shaped bracts; calyx cleft 1/4 to 1/3 its length with five hairy, broadly-deltate, reflexed lobes with rounded tips; corolla tubular, white, to 12 mm long, densely hairy (Wagner *et al.* 1999). Fruits are white berries with small seeds. Phenology: Not well studied, but in HAVO flowers were observed during July. Elsewhere, flowering occurs in the summer and fruits appear in December (U.S. Fish and Wildlife Service 1996).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island between 730 and 1,040 m (2,390–3,410 ft) elevation, previously known from windward Mauna Kea and recently seen in the **Laupāhoehoe Natural Area Reserve** (Wagner *et al.* 1999).

HAVO DISTRIBUTION: Recently discovered (2001) growing on the lower walls of a prominent geological **feature and adjacent craters in the northeast quarter of `Ōla`a Forest at 1,100 m (3,600 ft) elevation** (Waite and Pratt 2007).

HABITAT: In HAVO the bell ha`iwale grows at the base of steep crater cliffs or among talus boulders in **montane wet forest of `ōhi`a lehua, other native trees, and hāpu`u pulu**. Elsewhere the species is not associated with craters.

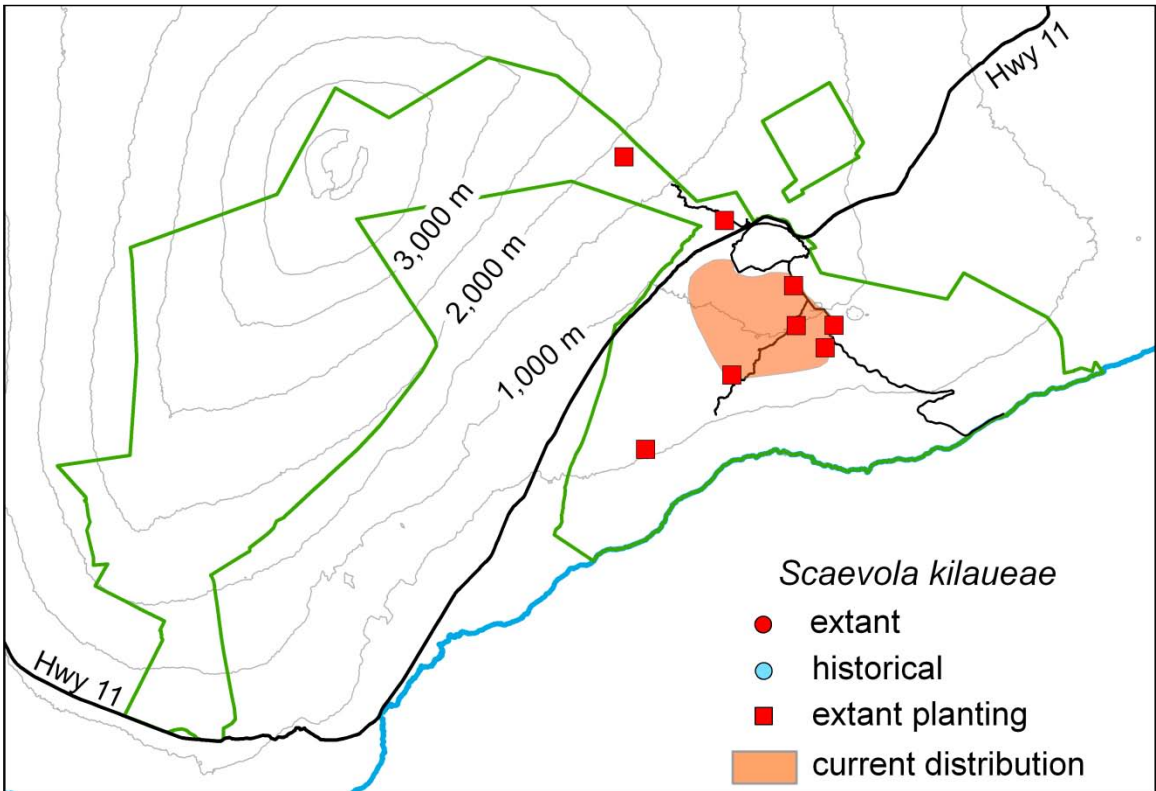
SIMILAR SPECIES: `Ilihia or *Cyrtandra platyphylla*, which occurs in the same area and habitat, is similar to this rare species vegetatively. However, the distinctive inflorescence of *C. tintinnabula* is much congested and the calyx lobes of the flowers are triangular and strongly curled back (reflexed). The leaves of *C. tintinnabula* superficially resemble those of *C. platyphylla*, but may be recognized by their obviously asymmetrical bases.

THREATS: Ha`iwale shrubs have weak, brittle stems vulnerable to damage from feral ungulates. Alien plants may displace understory plants. Palmgrass, Vasey grass, and strawberry guava have invaded the habitat of the bell ha`iwale in HAVO. Loss of pollinators and small population size may be problems (U.S. Fish and Wildlife Service 1996).

MANAGEMENT/RESTORATION STRATEGIES: Fencing and removal of feral pigs are planned to protect **sites supporting the bell ha`iwale within the trench feature in `Ōla`a Forest (R. Loh, pers. comm.)**. Fencing this crater habitat may also afford protection for other plants rare in the park (e.g., koli`i, hāhā) and provide sites for planting. After fencing, control of alien grasses and strawberry quava will likely be required. Pollination studies on this and other rare ha`iwale may be useful to managers.

REMARKS: The discovery of about 50 plants of this critically endangered species within HAVO more than doubles the total number of known individuals and extends the range of the species by more than 30 km. Mauna Loa was not previously known to support bell ha`iwale. The park population appears to have both adult and young plants; if adult plants persist, they may be used as seed donors in a future recovery program. **Recently the species has been observed in Waiākea Forest Reserve (K. Magnacca, pers. comm.)**.

CULTURAL USES/ETHNOBOTANY: None known.



Huahekili uka, Kilauea naupaka, *Scaevola kilaueae*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Huahekili uka, Kīlauea naupaka**

SCIENTIFIC NAME: *Scaevola kilaueae*

FAMILY: Goodeniaceae (Goodenia Family)

SYNONYMS: *Scaevola kilaueae* var. *powersii*

FEDERAL AND STATE STATUS: Species of Concern, formerly a Candidate

DESCRIPTION: Low shrub, typically less than 1 m tall. Leaves alternate, thick and almost succulent, oblanceolate, 3–7 cm long and 1–1.5 cm wide, smooth and hairless; margins toothed near tip; petioles <1 cm long. Flowers are in clusters of three to seven with an inflorescence stalk 1.5–4 cm long; calyx is tiny, green, and five-parted; the corolla is irregular, with its five lobes on one side, giving the appearance of a “half-flower;” corolla tube is purplish brown, 20–24 mm long, and the lobes are yellow or cream with purple stripes, 8–10 mm long; five stamens are shorter than the corolla; the style is 23–30 mm long, slightly exserted from the corolla. Fruits are fleshy drupes, ovoid, 10 mm long, purple-black when ripe. Seeds are two per fruit, contained within a stony endocarp (Wagner *et al.* 1999). Phenology: Flowers in both summer and winter.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island between 1,000 and 1,460 m (3,280–4,790 ft) elevation (Wagner *et al.* 1999); concentrated on Kīlauea south of the caldera; also known from east of the park near Pāhoā, west of the park on Kapāpala Ranch, and on Mauna Loa’s southwest rift at Ocean View Estates.

HAVO DISTRIBUTION: Scattered throughout the Ka`ū Desert south of Kīlauea Caldera, distributed from the upper Chain of Craters in the east to the Keā`moku Flow in the west; plants are particularly noticeable along the upper Hilina Pali Road. Planted near Kīpuka Puauulu, at `Āinahou Ranch, Kīpuka Pepeiau, and at several sites along the Chain of Craters and Hilina Pali Roads. A recent planting was made in Kīpuka Kulalio of the Mauna Loa Strip.

HABITAT: Montane dry, open `ōhi`a lehua forest and shrubland on old `a`ā and ash substrates.

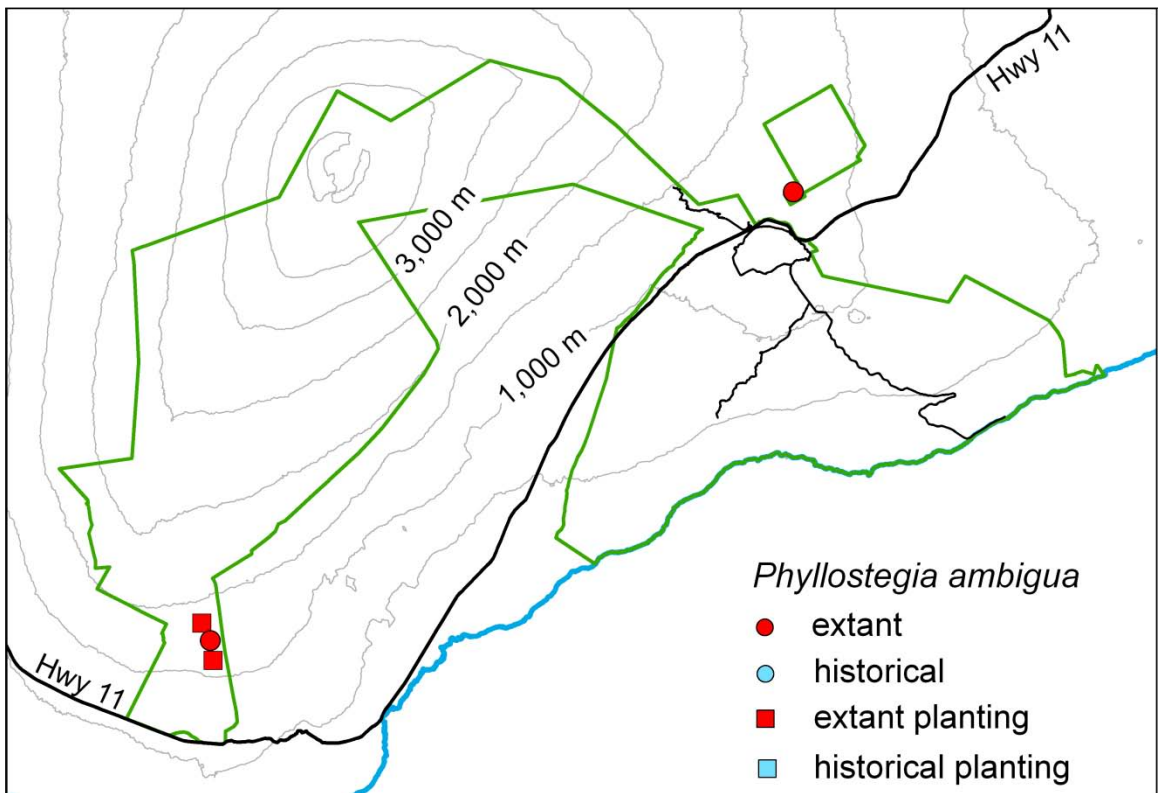
SIMILAR SPECIES: Two additional species of naupaka grow in HAVO. Naupaka kahakai (*Scaevola taccada*) is restricted to the coastal lowlands and has very thick and succulent, large leaves and round, white fruits. Naupaka kuahiwi (*Scaevola chamissoniana*) is a small tree of the rain forest with large, thin leaves. Its white and purple-streaked flowers (to 45 mm) and shiny purple-black fruits (12–14 mm) are larger than those of huahekili uka (Wagner *et al.* 1999).

THREATS: Feral goats threaten this rare shrub in unprotected areas outside HAVO. Alien grasses and shrubs, particularly firetree or faya, may compete with Kīlauea naupaka. Fire may be an additional cause of mortality in shrublands invaded by alien grasses.

MANAGEMENT/RESTORATION STRATEGIES: The habitat of Kīlauea naupaka in HAVO is free of feral goats, although feral pigs are still present in some areas. Faya trees are controlled in the Hilina SEA. Fire is suppressed throughout the park. In the 1970s, this species was successfully planted at `Āinahou Ranch and at sites along the Chain of Craters Road, where realignments had disturbed natural vegetation (N. Zimmer, unpublished data). Recently several hundred plants were planted in the broomsedge fire restoration site south of Kīpuka Puauulu (Loh *et al.* 2007), at a fire restoration site near Kīpuka Pepeiau (R. Loh, pers. comm.), and at several sites along Hilina Pali Road (Belfield *et al.* 2011). This species was introduced to the Mauna Loa Special Ecological Area; but few plants (3%) persisted six to seven years (Belfield *et al.* 2011). Because Kīlauea naupaka also occurs naturally at Ocean View Estates, it may be a candidate for introduction to protected sites within Kahuku Unit.

REMARKS: While this species is restricted in distribution, its relatively large population size, recovery after feral goat removal, and concentration within the protected national park suggest that it is unlikely to be listed as endangered.

CULTURAL USES/ETHNOBOTANY: Other naupaka species were used for dye (Krauss 1993).



Ambiguous Hawaiian mint, *Phyllostegia ambigua*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Ambiguous Hawaiian mint**

SCIENTIFIC NAME: *Phyllostegia ambigua*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Phyllostegia brevidens* var. *ambigua*, *P. b.* var. *heterodoxa*; *P. longimontis*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Viny shrub or liana with hairy stems. Leaves opposite, thick in texture, ovate or elliptic, 11–16 cm long and 4.5–7 cm wide, variably hairy (upper surface usually sparsely covered with hairs and lower surface densely hairy to hairless with age); margins toothed; petioles 2.5–4 cm long, hairy. Flowers borne in terminal, elongate, racemose inflorescences; flowers 6–18 per whorl, pedicels 6–30 mm long, usually densely hairy; calyx narrowly obconical, 7–11 mm long, hairy, teeth oblong to deltate and 2–4 mm long; corolla white, sparsely hairy, tube 12–14 mm long with two unequal lips, upper lip two-lobed and 8–15 mm long, larger lower lip 16–19 mm long; four stamens. Fruits are composed of four fleshy nutlets, 8–12 mm long, green when young and shiny black when mature (Wagner *et al.* 1999). Phenology: Flowers in the summer.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Maui and Hawai`i at elevations of 915 to 1,980 m (3,000–6,500 ft). On Hawai`i it is known primarily from Mauna Loa.

HAVO DISTRIBUTION: `Ōla`a Forest, known from a single site on the north side of the Small Tract (Pratt and Abbott 1997); Kahuku Unit in a large pit crater surrounded by pastureland near 1,250 m (4,100 ft) elevation (Benitez *et al.* 2008). Also planted at Kahuku Unit.

HABITAT: Montane wet forests to subalpine forests. In HAVO, the species has been found in wet **montane forest of `ōhi`a lehua and tree ferns and within a pit crater vegetated by `ōhi`a, māmakī, and native ferns.**

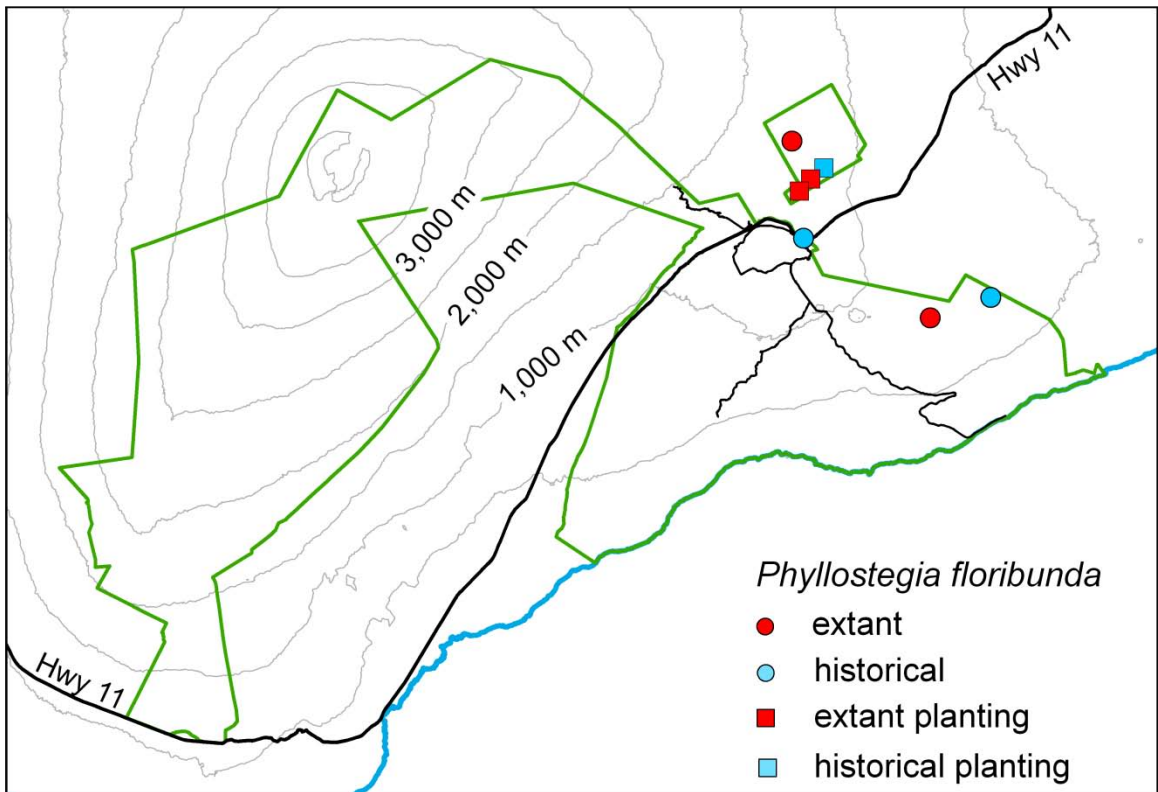
SIMILAR SPECIES: *Phyllostegia vestita* shares the wet forest habitat of *P. ambigua* at `Ōla`a Forest, but it has congested terminal inflorescences of white to pink flowers interspersed with leaves and leaf-like bracts. *Phyllostegia stachyoides* is similar to *P. ambigua*, but has smaller flowers, glandular hairs on flower calyces, and larger inflorescences with multiple branches.

THREATS: Feral pigs, goats, sheep, and domestic cattle are likely threats to unprotected wet forests supporting this species. Alien invertebrates may damage the leaves and inflorescences of plants.

MANAGEMENT/RESTORATION STRATEGIES: Wet forest habitat is protected within four pig-free **exclosures at `Ōla`a. The large forested pit crater at Kahuku is naturally protected from cattle and feral ungulates.** Propagation material was collected from the Kahuku pit crater in 2005, and plantings of this species were made in two experimental exclosures within the central pastures of Kahuku (McDaniel *et al.* 2008). More plantings of this species are planned for Kahuku Unit (S. McDaniel, pers. comm.). The impacts of rats on this species have not been studied, and identification of insect species responsible for damage to leaves and flowers has not been made.

REMARKS: This species appears to be highly variable and is sometimes difficult to identify. Wagner *et al.* (1999) comment that it is likely a species complex.

CULTURAL USES/ETHNOBOTANY: None known.



Many-flowered Hawaiian mint, *Phyllostegia floribunda*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Many-flowered Hawaiian mint**

SCIENTIFIC NAME: *Phyllostegia floribunda*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Phyllostegia floribunda* var. *forbesii*, *P. forbesii*, *P. villosa*

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: Small shrub with hairy stems. Leaves opposite, ovate, lanceolate, or elliptic, 12–24 cm long and 4.5–8.5 cm wide, variably hairy (ranges from almost hairless to densely covered with soft hairs), with pale lower surface; margins toothed; petioles 2.5–6.5 cm long, hairy. Flowers borne in axillary, racemose inflorescences; flowers two per whorl, pedicels 8–10 mm long; calyx obconical, 2–5 mm long, hairy, with 10 veins, teeth linear-lanceolate and 1.2–2.4 mm long; corolla maroon to red, covered with long soft hairs, tube 8–10 mm long with two unequal lips 2.5 and 5 mm long; four stamens; short style. Fruits are composed of four fleshy nutlets, 3–3.5 mm long, shiny black when mature (Wagner *et al.* 1999). Phenology: Flowers in the spring and summer and produces fruits in the summer (VanDeMark *et al.* 2010).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island at elevations of 430 to 1,130 m (1,410–3,710 ft); known from four disjunct areas: Kohala Mountains; Honokaia Gulch on Parker Ranch; **between Laupāhoehoe and Kīlauea (including HAVO); and near Pāhala, Ka`ū (Wagner *et al.* 1999).** The species was also collected in Kona by David Nelson in 1779 and by Forbes in 1911, but it is now apparently extirpated from those sites (St. John 1976).

HAVO DISTRIBUTION: `Ōla`a Forest, formerly at a site in the Ag Unit (Pratt and Abbott 1997); likely extant in **East Rift forest craters near Nāpau (Belfield 1998).** Formerly found in a kīpuka on the eastern park boundary near Pu`u `Ō`ō, now destroyed. Collected in forests of Kīlauea in the early 1900s (Sherff 1935). Planted in `Ōla`a Koa Unit and Small Tract.

HABITAT: Lowland or montane wet forests; `Ōla`a Forest is at an elevation (1,220 m or 4,000 ft) higher than the published upper range of the species. In HAVO, the species has been found in wet montane forest of `ōhi`a lehua and tree ferns.

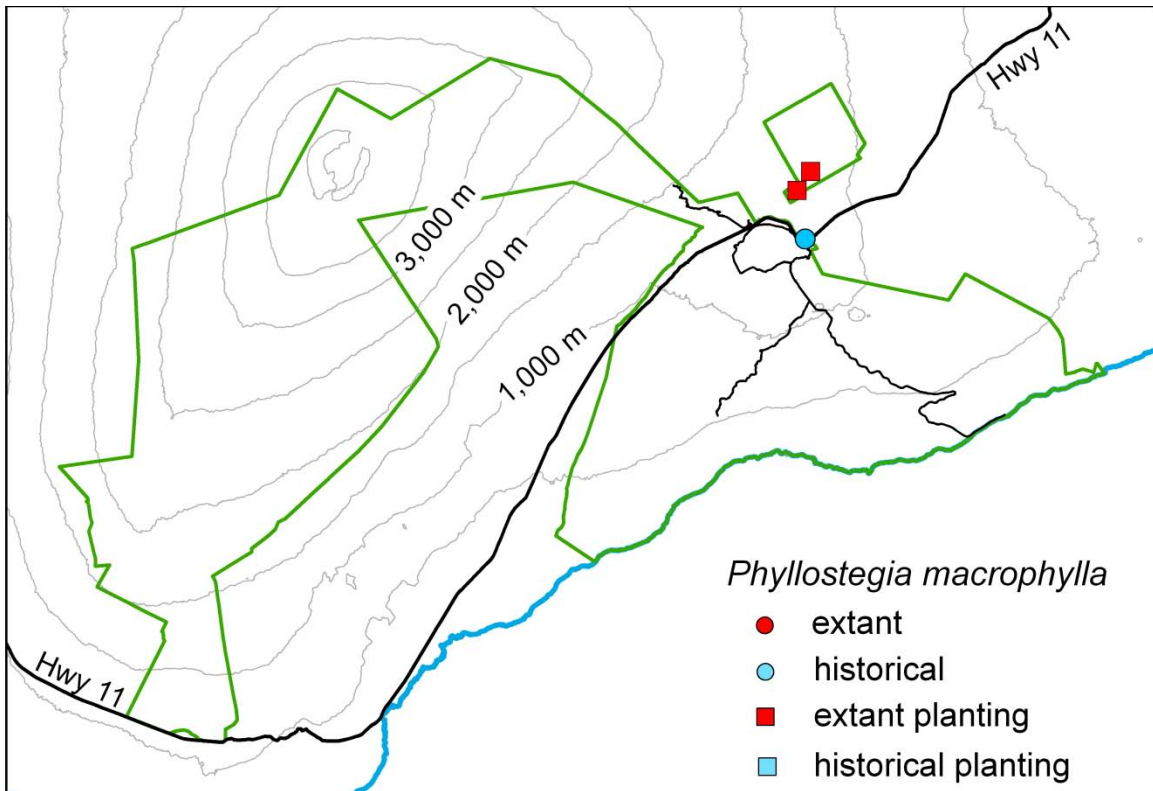
SIMILAR SPECIES: *Phyllostegia vestita* shares the wet forest habitat of *P. floribunda* and is similar vegetatively. Both species have leaves covered by soft hairs but may be distinguished by their inflorescences. *Phyllostegia vestita* has congested terminal inflorescences of white to pink flowers interspersed with leaves and leaf-like bracts, while the inflorescences of *P. floribunda* are borne in leaf axils and are composed of small maroon or bright red flowers.

THREATS: Feral pigs are likely the most significant threat to unprotected wet forests supporting this species. Alien invertebrates may damage foliage of *Phyllostegia*, and slugs are suspected seedling predators. Pollinators recently identified were alien (VanDeMark *et al.* 2010).

MANAGEMENT/RESTORATION STRATEGIES: Sites supporting this species in HAVO are within feral pig enclosures in Special Ecological Areas: **the `Ōla`a Forest Ag Unit and the East Rift SEA.** More than 170 plants total were recently planted in Koa Unit and Small Tract, and >20% persisted for four to six years (Belfield *et al.* 2011). A more recent experimental planting of 75 seedlings failed in `Ōla`a (VanDeMark *et al.* 2010). This mint is planned for re-introduction to the Nāhuku (Thurston) and East Rift SEAs (Loh 2008a). If *P. floribunda* is to remain part of the park's flora, it may require continued restoration efforts. Study of the impact of alien slugs on Hawaiian mint seedlings is desirable.

REMARKS: This species has been known by three specific and varietal names, based on the degree of hairiness of leaves (St. John 1976). Populations near HAVO are in **`Ōla`a Forest Reserve (behind the Volcano Transfer Station) and Waiākea Forest Reserve north of HAVO.** Many-flowered mints of HAVO and vicinity have leaves covered with soft hairs (villous).

CULTURAL USES/ETHNOBOTANY: None known.



Large-leaved Hawaiian mint, *Phyllostegia macrophylla*
Photo: Thane Pratt, USGS, PIERC

COMMON NAME: **Large-leaved Hawaiian mint**

SCIENTIFIC NAME: *Phyllostegia macrophylla*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Phyllostegia clavata*; *P. macrophylla* var. *phytolaccaoides*, *P. m.* var. *remyi*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Perennial herb or vine. Stems densely hairy. Leaves ovate to broadly ovate, 8.5–15.5 cm long, 4–8 cm wide; both surfaces with stiff, appressed hairs, more dense along midvein; margins toothed with teeth pointing out or forward; apex acuminate, base cuneate to truncate; petioles 1.4–4 cm long and densely to sparsely hairy. Flowers in unbranched racemose terminal inflorescences with many whorls of six to ten flowers. Flower pedicels 4–8 mm long, variably hairy. Flower calyx broadly cone-shaped, 3–5 mm long, covered with stiff forward-facing hairs, teeth deltate with rounded tips. Flower corolla white, tinged with pink, tube curved 7–12 mm long, densely hairy with stiff forward-facing hairs. Stamens four in two pairs. Style two-lobed, within the corolla. Fruits are four fleshy nutlets 2.5–4 mm long (Wagner *et al.* 1999). Phenology: Fruits were borne on herbarium specimens in the summer (July).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: East Maui and eastern Hawai`i at elevations between 750 and 1,230 m (2,460–4,035 ft) (Wagner *et al.* 1999).

HAVO DISTRIBUTION: Current distribution of natural plants unknown. Higashino *et al.* (1988) listed the species from montane rain forest in HAVO. There is a **collection in the HAVO Herbarium from the `Ōla`a Forest Reserve behind the Volcano Transfer Station, so this mint may occur in `Ōla`a Forest. Hillebrand collected the species in forests of Kīlauea in 1868 (Sherff 1935). Planted in `Ōla`a Small Tract and Koa Unit.**

HABITAT: Montane wet forest.

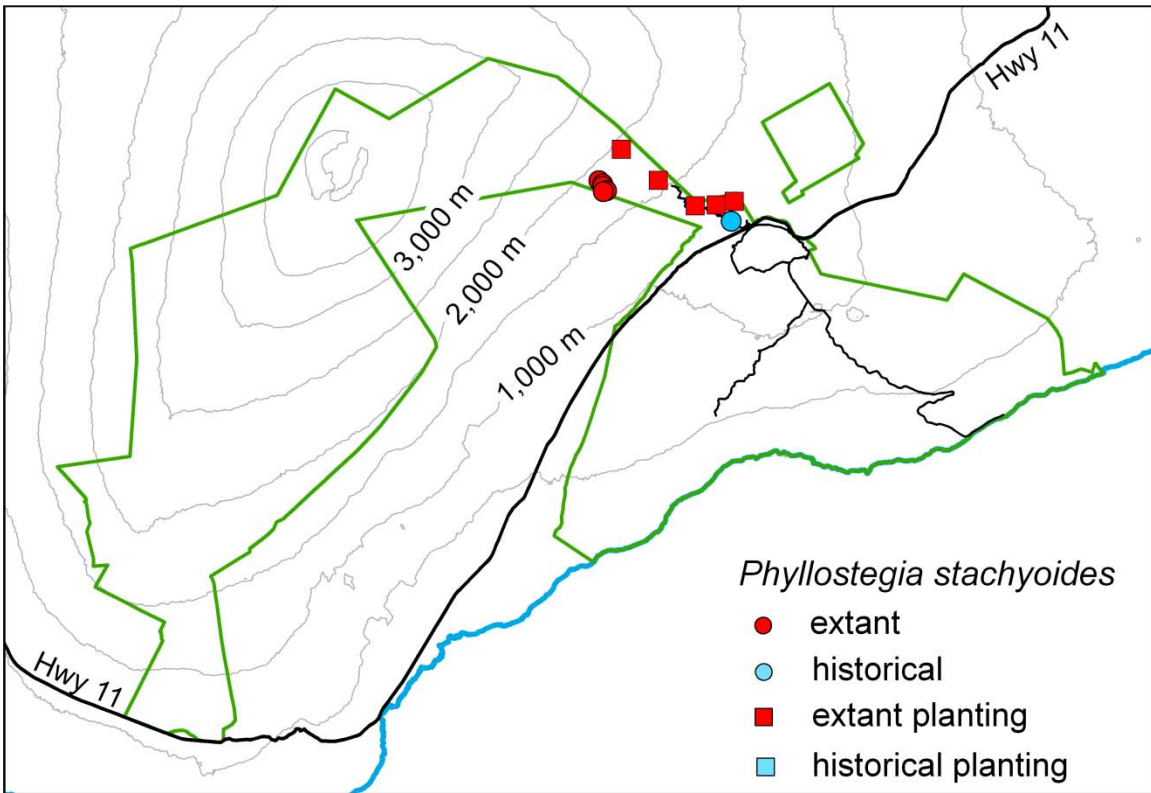
SIMILAR SPECIES: Both *Phyllostegia vestita* and *P. floribunda* are also found in `Ōla`a and occur rarely in East Rift forests. *Phyllostegia vestita* has congested terminal inflorescences of white to pink flowers interspersed with leaves and leaf-like bracts, and its calyx lobes are large and foliaceous, while those of *P. macrophylla* are small with triangular teeth. *Phyllostegia floribunda* is an upright shrub, and it has axillary inflorescences of red flowers compared with the terminal inflorescences of white flowers in *P. macrophylla*.

THREATS: Feral pigs are threats in unprotected forest. Invertebrates, such as insects and slugs, may damage foliage, and slugs are suspected seedling predators. Pollinators and seed dispersers are unknown.

MANAGEMENT/RESTORATION STRATEGIES: Forests of western `Ōla`a and the eastern Kīlauea summit are pig-free, and the most invasive alien plants are controlled. Surveys to find this rare plant in `Ōla`a would help establish its range there. Recently, plants from material collected in Waiākea Forest Reserve were planted in the Small Tract and Koa Units of `Ōla`a Forest (T. Belfield, pers. comm.); success of this planting is unknown. Research on pollinators and the impacts of slugs and other alien invertebrates is warranted for this and many other species of rare plants in wet forest habitat.

REMARKS: This species was not observed in a survey of rare plants in managed units of `Ōla`a Forest (Pratt and Abbott 1997), nor was it found in a survey of East Rift forests (Pratt *et al.* 1999). There is a **specimen in the Bishop Museum Herbarium from Kīlauea (with no date), and the species has been observed in Pu`u Maka`ala Natural Area Reserve (Hawai`i Department of Land and Natural Resources 1989).**

CULTURAL USES/ETHNOBOTANY: None known.



Stachys-like Hawaiian mint, *Phyllostegia stachyoides*

Photos: Linda Pratt, USGS, PIERC, plant; Thomas Belfield, PCSU/NPS, HAVO, flowers

COMMON NAME: **Stachys-like Hawaiian mint**

NAME: *Phyllostegia stachyoides*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Phyllostegia stachyoides* var. *hitchcockii*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: A perennial herb or sub-shrub weakly erect or climbing, with hairy stems. Leaves opposite, rugose, lanceolate to ovate, 6–17 cm long and 2–6 cm wide, both surfaces moderately to sparsely strigose, densely so along veins, lower surface usually glandular-dotted; tip of leaves acute to acuminate; margins toothed; petioles 2.5–7 cm long, moderately to densely hairy with hairs pointing forward. Flowers borne in terminal compound racemose inflorescences; flowers 10–14 per whorl, pedicels 2–7 mm long, villous; calyx campanulate, 3.5–8 mm long, covered with short stiff hairs and dotted with glands, calyx lobes linear to linear-deltate and 2–4 mm long, pubescent; corolla white, pink-tinged upper lip, tube curved ca. 6–12 mm pubescent. Fruits are composed of four fleshy nutlets, 3 mm long (Wagner *et al.* 1999). Phenology: Flowers in the spring and summer.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Known from eastern Moloka`i, West Maui, and Hawai`i between elevations of 880 and 1,400 m (2,890–4,590 ft) (Wagner *et al.* 1999). On Hawai`i Island in North and South Kona and **Ka`u District (Bishop Museum Herbarium)**.

HAVO DISTRIBUTION: Currently known from five **kīpuka in HAVO**, at about 1,800 m (5,900 ft) elevation **near Kīpuka Mauna`iu of the Mauna Loa Strip**. Also planted at two sites on the Mauna Loa Road and in three small **kīpuka near Kīpuka Puaulu**. **Historically this species was collected in Kīpuka Puaulu in 1915**, but the species has been lost from that area.

HABITAT: Montane mesic to wet forest. In HAVO, the species also occurs in montane dry forest of koa, **māmane, and** naio with an understory of `a`ali`i and a ground cover of alien meadow ricegrass and native mountain pili.

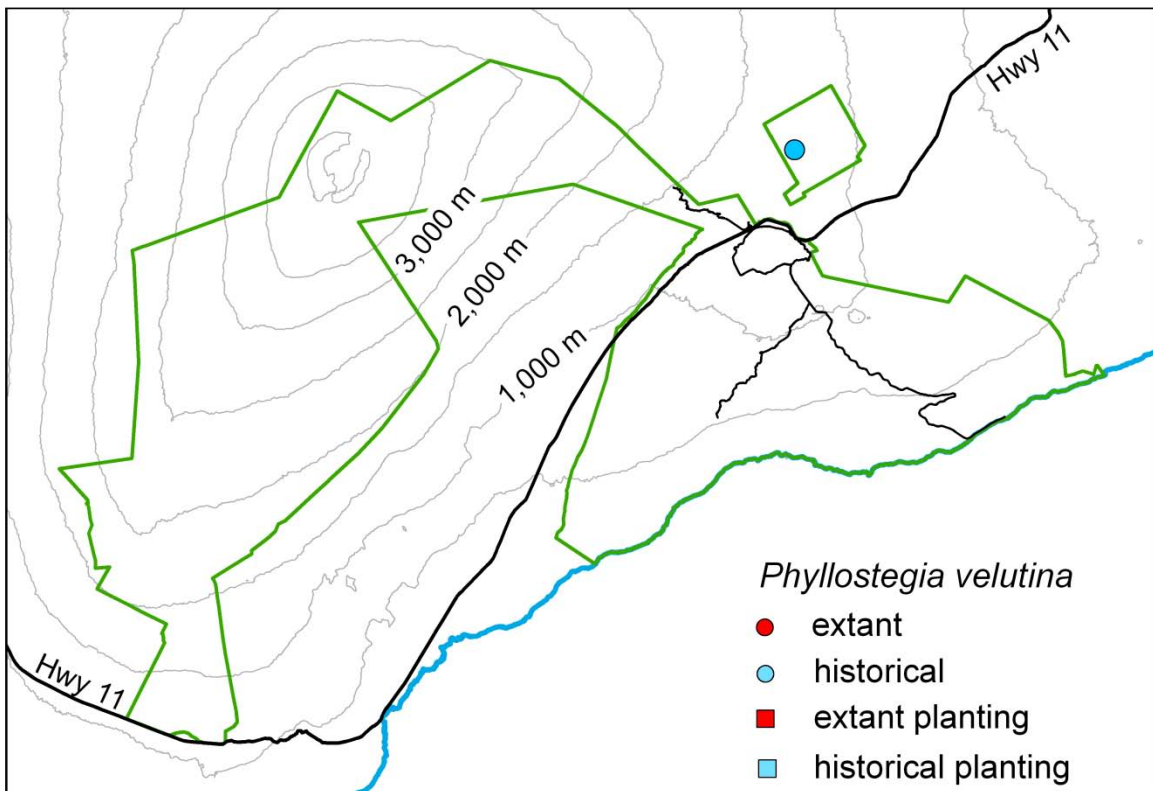
SIMILAR SPECIES: The only other native mint found in the Mauna Loa Strip or Kīpuka Puaulu is *Stenogyne rugosa*, which has hairless or sparsely hairy leaves with sharp marginal teeth and dull red to greenish-yellow flowers borne in whorls among leaves. The floral structure of *Stenogyne* differs from *Phyllostegia*; *Stenogyne* flowers have an upper lip longer than the lower lip, and *Phyllostegia* flowers have a longer lower lip.

THREATS: Within HAVO, mouflon sheep incursions are a potential threat. Alien grasses and shrubs, such as poha, Spanish needle, and Jerusalem cherry are competitors that may threaten the species. Other feral animals and fire are potential threats.

MANAGEMENT/RESTORATION STRATEGIES: The habitat of *P. stachyoides* in HAVO is protected within a **fenced unit of the Mauna Loa SEA and Kīpuka Puaulu**. **All feral animals, including** mouflon sheep, have been removed. Volunteers control weeds at the natural population. More than 130 seedlings and cuttings were recently (2004–2007) planted at two sites near 1,710 and 1,830 m (5,600–6,000 ft) elevation along the Mauna Loa Road, and about 1/3 survived for more than two years (Pratt *et al.* in prep.). **Additional plantings were made in 2009 at small kīpuka near Kīpuka Puaulu** (S. Dale, pers. comm.). Woodlands of the Kahuku Unit may also provide planting sites for this rare mint, since it is known from South Kona District.

REMARKS: *Phyllostegia stachyoides* is documented from Kīpuka Puaulu by a collection made by Charles Forbes in 1915. Unfortunately, the place name is misspelled on the label, which reads “Punaulu.” In his monograph of Hawaiian mint genera, Sherff (1935) reported the Forbes collection from Pu`u Hualālai. Because of this place name confusion, Wagner *et al.* (1999) listed the Hawai`i Island range of the species as North and South Kona only and omitted Ka`u District.

CULTURAL USES/ETHNOBOTANY: None known.



Velvety Hawaiian mint, *Phyllostegia velutina*
Photo: Linda Pratt, USGS, PIERC

COMMON NAME: **Velvety Hawaiian mint**

SCIENTIFIC NAME: *Phyllostegia velutina*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Phyllostegia macrophylla* var. *velutina*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1996

DESCRIPTION: A perennial vine with densely hairy stems. Leaves opposite, narrowly ovate, 7.5–14 cm long and 2–5 cm wide, densely silky strigose, tip of leaves acute to acuminate, base of leaves wedge-shaped to truncate; margins serrate; petioles 1.7–3.5 cm long, densely strigose with hairs pointing forward. Flowers borne in terminal racemose inflorescences 10–15 cm long; flowers 6–10 per whorl, pedicels 3–10 mm long, densely covered with shaggy hairs; calyx campanulate, 6–7 mm long, with long forward-pointing hairs, calyx lobes triangular and 1–2 mm long; corolla white, tube slightly curved, ca. 12 mm long, densely hairy. Fruits are composed of four fleshy nutlets, 4–5 mm long (Wagner *et al.* 1999). Phenology: Flowers in the spring, based on herbarium specimens.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai'i Island, found in the area between **Kīlauea and Pu`u Kipu in upper Kīlauea Forest, as well as above Nā`ālehu (Wagner *et al.* 1999); persists in the Kīlauea Forest/Keauhou/Kūlani area. Also known from Pu`uwa`awa`a on Hualālai and Waiea Tract in South Kona (U.S. Fish and Wildlife Service 1998c). Historically, the mint was found at Pu`u Lehua in Kona and on Mauna Kea (Sherff 1935).**

HAVO DISTRIBUTION: Collected in `Ōla`a Forest, on the western edge of the Ag Unit in 1976, not seen in the park since then, apparently extirpated from HAVO.

HABITAT: Montane mesic to wet forest. In HAVO, the species occurred in montane forest of `ōhi`a lehua and hapu`u tree ferns.

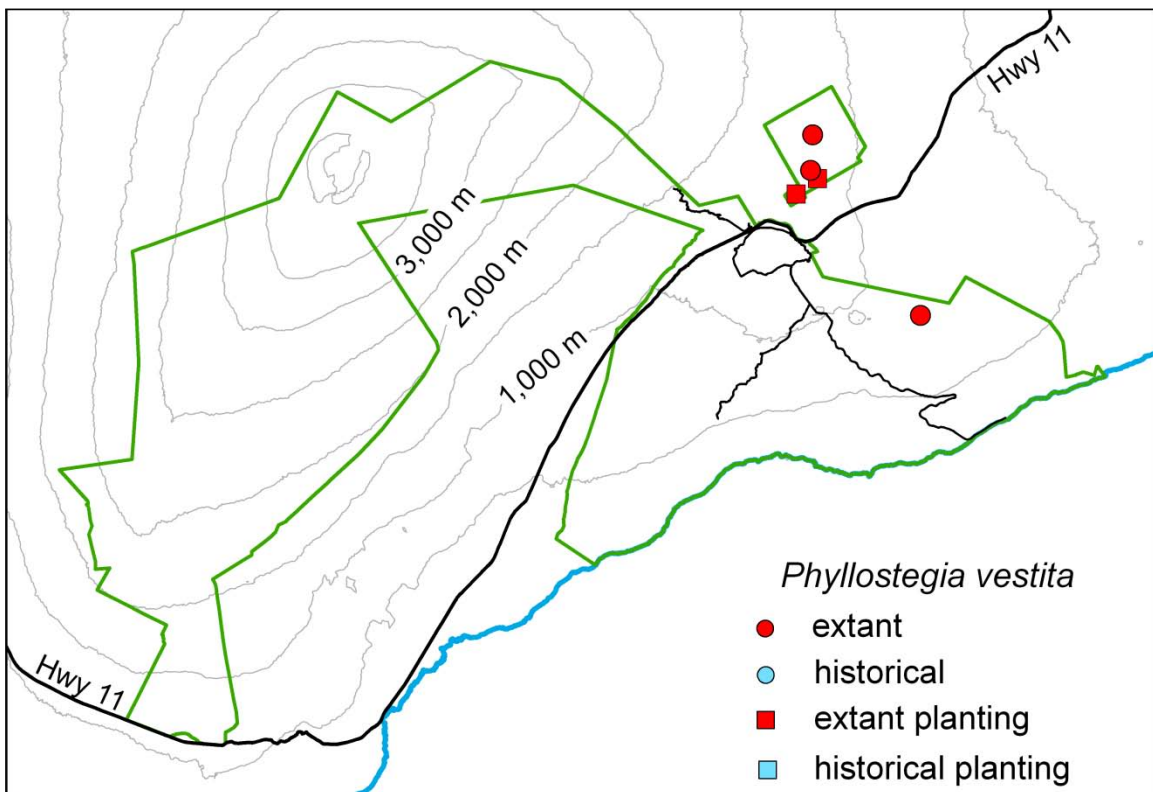
SIMILAR SPECIES: Both *Phyllostegia vestita* and *P. floribunda* are also found in `Ōla`a forest, and *P. ambigua* and *P. macrophylla* may be present. *P. vestita* has congested terminal inflorescences of white to pink flowers interspersed with leaves and leaf-like bracts, and its calyx lobes are large and leaf-like, while the flowers of *P. velutina* are borne in long terminal inflorescences and are white with small, triangular, densely hairy calyx lobes. *Phyllostegia floribunda* is an upright shrub branching from the base with axillary inflorescences of red flowers compared with the terminal racemose inflorescences of white flowers in *P. velutina*. All five of these mint species may have hairy leaves, but those of *P. velutina* are densely covered with silky, stiff, appressed hairs.

THREATS: Feral pigs are the greatest threat to Hawaiian mints in unprotected forest. Invertebrate herbivores are potential threats, and slugs are suspected of killing or damaging Hawaiian mint seedlings. Pollinators and seed dispersers are unknown. The recovery plan for the species listed cattle, feral ungulates, road-clearing, logging, competition from alien plants, fire, volcanic activity, and reduced **reproductive vigor as reasons for this mint's decline** (U.S. Fish and Wildlife Service 1998c).

MANAGEMENT/RESTORATION STRATEGIES: The area in which the velvety Hawaiian mint occurred is **now within a managed unit of the `Ōla`a Special Ecological Area, where the forest is protected from feral pigs and other ungulates and invasive alien plant species are controlled. The velvety Hawaiian mint is a species suitable for restoration to `Ōla`a Forest. Study of the impacts of slugs on seedlings is warranted.**

REMARKS: This mint species was collected only **once within HAVO near a research plot of the `Ōhi`a Rain Forest Study in 1976 (Mueller-Dombois *et al.* 1977). The specimen (Balakrishnan and Jacobi 1050) is stored at the Bishop Museum Herbarium.**

CULTURAL USES/ETHNOBOTANY: None known.



Clothed Hawaiian mint, *Phyllostegia vestita*
Photo: Linda Pratt, USGS, PIERC

COMMON NAME: **Clothed Hawaiian mint**

SCIENTIFIC NAME: *Phyllostegia vestita*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Phyllostegia dentata*

FEDERAL AND STATE STATUS: No status (federal), Species of Concern (state of Hawai`i)

DESCRIPTION: A perennial vine with densely hairy stems. Leaves opposite, lanceolate to ovate to elliptic-ovate, 15–24 cm long and 6.5–11 cm wide, both surfaces conspicuously hairy (strigose); tip of leaves acuminate; base of leaves rounded, truncate, or heart-shaped; margins serrate or serrulate (with forward-pointed teeth); petioles 2.5–7.5 cm long, densely hairy with stiff, coarse hairs (hirsute). Flowers borne in terminal congested racemose inflorescences to 30 cm long; flowers 10–20 per whorl, pedicels 6–13 mm long, with shaggy stiff hairs; calyx asymmetrical, 12–20 mm long, shaggy-hirsute, calyx lobes foliaceous and 5–10 mm long, less hairy than tube, with irregular teeth; corolla white, pink-tinged tube 8–15 mm long and hairy, upper lip of corolla 6–8 mm long, lower lip 10–15 mm long. Fruits are composed of four fleshy nutlets, 4 mm long (Wagner *et al.* 1999). Phenology: Flowers and fruits are borne in spring and summer.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i Island, known from Kohala and the windward slopes of Mauna Kea and Mauna Loa between 365 and 1,325 m (1,200-4,350 ft).

HAVO DISTRIBUTION: `Ōla`a Forest, found in the Koa and New units below 1,220 m (4,000 ft) elevation (Pratt and Abbott 1997) and forests of the East Rift Special Ecological Area in the crater of Kane Nui o Hamo (Belfield 1998). Also planted in `Ōla`a Koa Unit and Small Tract.

HABITAT: Montane wet forest of `ōhi`a lehua and hāpu`u tree ferns (*Cibotium* spp.). Elsewhere on the island this mint occurs along streambeds and in shaded sites of wet forest (Wagner *et al.* 1999).

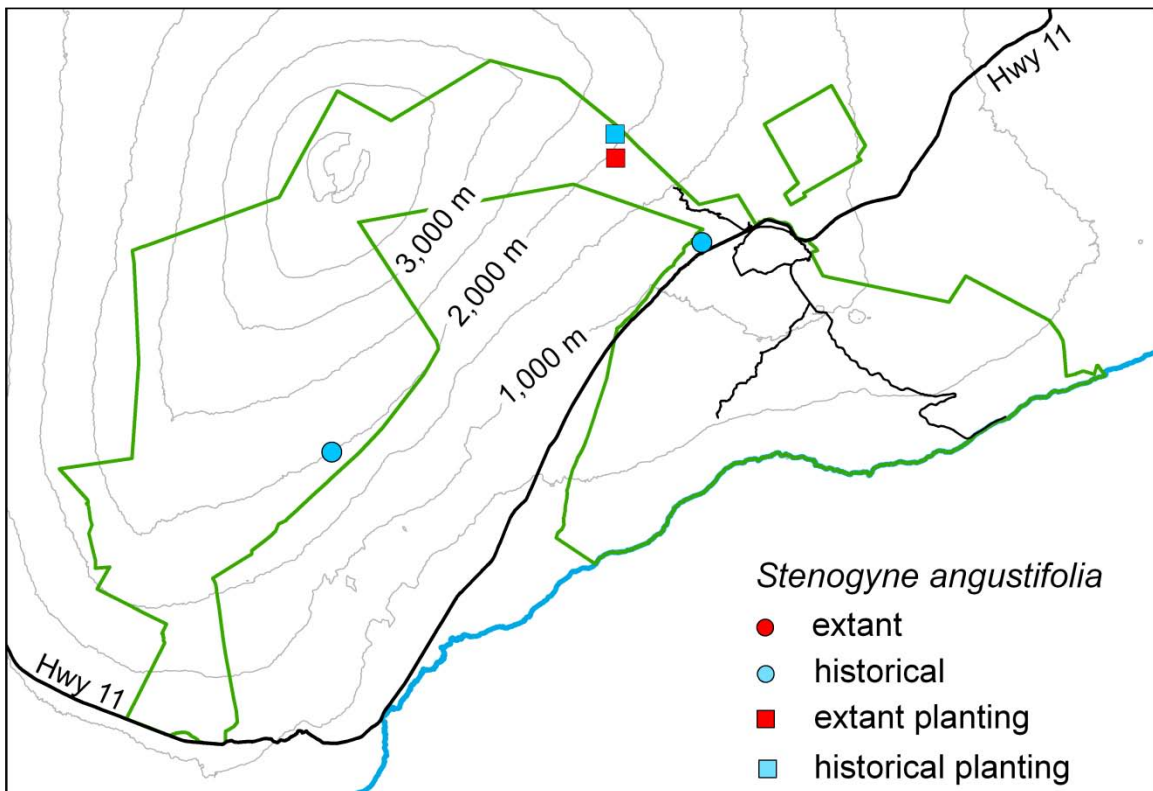
SIMILAR SPECIES: *Phyllostegia floribunda*, planted in the same area of `Ōla`a, is an upright shrub with smaller leaves and axillary rather than terminal flowers, red or maroon in color. *Phyllostegia ambigua* is very rare in `Ōla`a; this mint has leaves less hairy than *P. vestita* and elongate, rather than congested, terminal inflorescences of white flowers.

THREATS: Feral pigs are a threat to unprotected wet forests supporting this species. Insect herbivory has been noted on leaves, but it is unknown whether damage is caused by native or alien invertebrates. Slugs are potential threats to Hawaiian mint seedlings. Pollinators are unknown. Mints of this species may be short-lived plants.

MANAGEMENT/RESTORATION STRATEGIES: Feral pigs have been removed from the `Ōla`a Koa Unit (and three other units), and the most invasive alien plants are controlled in the habitat of this Hawaiian mint. In 2002–2003, plantings of more than 70 plants were made in the Koa Unit and a few individuals were planted in Small Tract; survival has been relatively poor, <10% (Belfield *et al.* 2011). Future plantings of this mint are planned for the Nāhuku (Thurston Lava Tube) Special Ecological Area (McDaniel *et al.* 2008). Research on the impacts of slugs and other alien invertebrates may be warranted.

REMARKS: This Hawaiian mint is very rare in HAVO, but appears to be more abundant elsewhere on Hawai`i Island, particularly in Kohala District where many plants have been observed (S. Perlman, pers. comm.). The species was recently deleted from a list of Species of Concern maintained by the U.S. Fish and Wildlife Service Honolulu office (U.S. Fish and Wildlife Service 2008).

CULTURAL USES/ETHNOBOTANY: None known.



Narrow-leaved Hawaiian mint, *Stenogyne angustifolia*
Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Narrow-leaved Hawaiian mint**

SCIENTIFIC NAME: *Stenogyne angustifolia*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Stenogyne angustifolia* var. *hillebrandii*, *S. a.* var. *mauiensis*, *S. a.* var. *meeboldii*, *S. a.* var. *salicifolia*, *S. a.* var. *spathulata*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1979

DESCRIPTION: Vine with four-angled stems. Leaves opposite, narrow, ovate or elliptic, lanceolate, or oblanceolate, 3–6 cm long and <1–1.5 cm wide, smooth and hairless, apex and base acute; margins with small teeth; petiole 4–16 mm long. Flowers are borne in whorls in axils of leaves at branch tips; two flowers per whorl, flower stalk 2–8 mm long, hairy; calyx with two lips, bell-shaped, 8–18 mm long, hairless, with pointed calyx teeth 5–9 mm long; corolla yellow, pink, or red, hairy on outside, tube straight or slightly curved, 1–2 cm long, upper lip 5–10 mm long and lower lip only 2 mm long. Fruits are fleshy nutlets, four clustered together (Sherff 1935, Wagner *et al.* 1999). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Moloka`i, Maui, and Hawai`i Island; extant only on **Hawai`i at Pōhakuoa Training Area (PTA) and nearby lands between 1,550 and 2,150 m (5,080–7,050 ft)** elevation. Formerly found at lower elevation on the cliffs of Kalaupapa, Moloka`i and at Kula and Honua`ula, Maui. On the island of Hawai`i, the species was collected at Hu`ehu`e, North Kona near 915 m (3,000 ft) elevation in 1932; near Waimea in 1840; at an unknown locality in the early 1850s; and in **Ka`ū District in 1868 (Sherff 1935)**.

HAVO DISTRIBUTION: Reported from the area between Kīlauea and Kapāpala in 1868 (Sherff 1935); included by Fosberg (1966) on his HAVO plant checklist because of this historical collection that may have been within the current park boundaries. Planted at two sites in the Mauna Loa Strip. Collected at an unknown locality in Kahuku in the 1930s (Benitez *et al.* 2008) and **in woodland above the Ka`ū Forest Reserve in the 1970s (R. Warshauer, pers. comm.)**.

HABITAT: The extant population at PTA is found in subalpine dry shrubland, but plants of Moloka`i, Maui, and leeward Hawai`i formerly occurred in montane dry habitats.

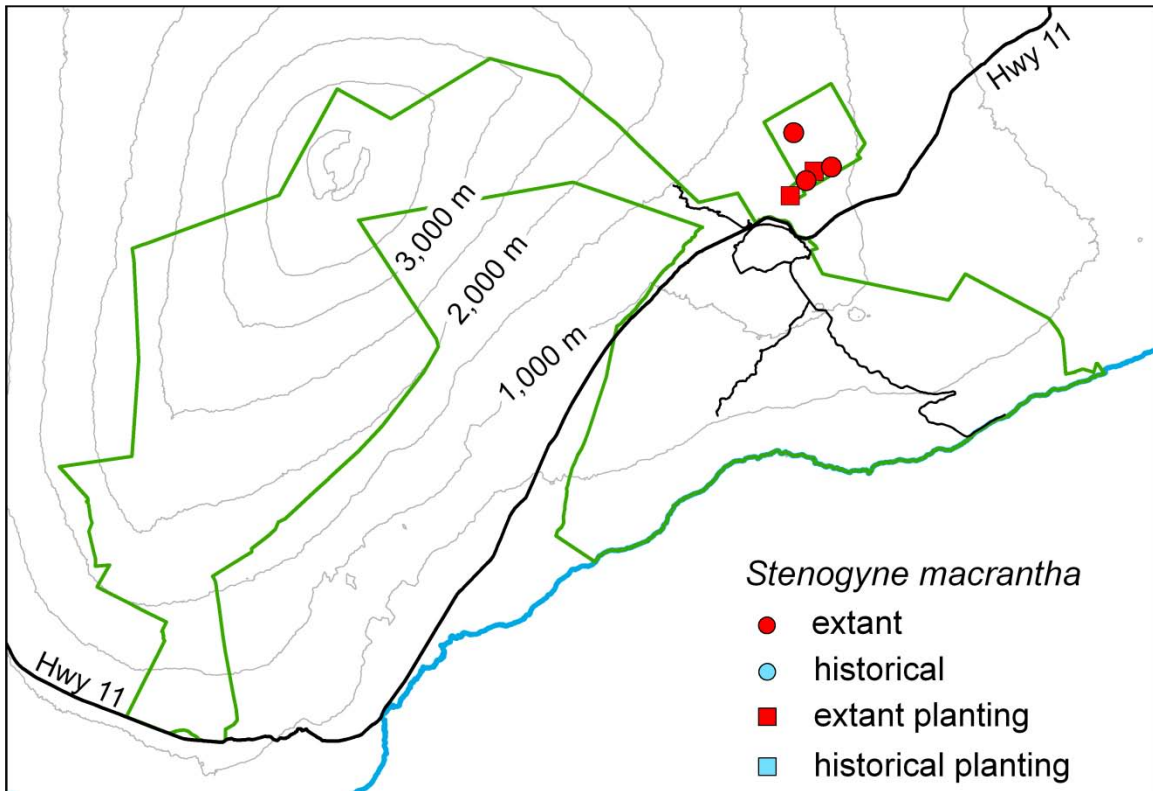
SIMILAR SPECIES: Mā`ohi`ohi or *Stenogyne rugosa* is the most similar-looking species that occurs within the possible habitat of *S. angustifolia* in HAVO. *Stenogyne rugosa* differs from *S. angustifolia* in its larger leaves with cordate bases and its larger whorls of up to 16 flowers, dull red or green in color with small upper lips.

THREATS: Fire, cattle, mouflon sheep, feral goats, feral sheep, and alien plants are potential threats, although Shaw (1997) reported the mint was not palatable to feral sheep and goats.

MANAGEMENT/RESTORATION STRATEGIES: This species disappeared from the areas that became Hawai`i National Park between 35 and 140 years ago. HAVO currently contains protected ungulate-free habitat that is likely suitable for re-introduction of this species. Alien plant cover is low in the fenced upper Mauna Loa Strip, and fires are suppressed. Recently, propagation material became available from PTA, and in 2005–2007 >200 narrow-leaved Hawaiian mint plants were introduced at two sites above 1,830 m (6,000 ft) elevation on the Mauna Loa Strip. However, survival of plantings has been poor (1%), and one planting site lost all plants (Belfield *et al.* 2011). Alternative planting sites may be needed to adequately restore this species to the park. Based on early collections, this species may be appropriate for introduction to protected subalpine sites within the Kahuku Unit.

REMARKS: While narrow-leaved Hawaiian mint seems to be secure at PTA with an estimated >100,000 plants (Shaw 1997), the species has apparently been lost from all other areas of its historical range. Sherff (1935) listed nehenehe as the common name for Moloka`i plants.

CULTURAL USES/ETHNOBOTANY: None known.



Large-flowered Hawaiian mint, *Stenogyne macrantha*

Photos: Thomas Belfield, PCSU/NPS, HAVO, vine; Stephen G. Weller, © Smithsonian Institution Botany Department, flower

COMMON NAME: **Large-flowered Hawaiian mint**

SCIENTIFIC NAME: *Stenogyne macrantha*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Stenogyne macrantha* var. *gracilis* f. *hispida*, *S. m.* var. *grayii*, *S. m.* var. *latifolia*

FEDERAL AND STATE STATUS: Species of Concern, formerly a Candidate

DESCRIPTION: Vine with round stems, hairy. Leaves opposite, broadly ovate or elliptic, 3–9 cm long and ca. 2–6 cm wide, covered with soft hairs, apex acute and base heart-shaped or truncate; margins with large teeth; petiole 7–24 mm long, densely hairy. Flowers are borne in whorls in axils of leaves at branch tips; six to eight flowers per whorl, flower stalk 8–16 mm long, densely hairy; calyx with two lips, bell-shaped, 8–17 mm long, densely hairy, with pointed calyx teeth 2–7 mm long; corolla pale yellow-green or reddish (L. Pratt, pers. obs.), hairy on outside, tube strongly curved, 12–28 mm long, upper lip 5–13 mm long and lower lip 4–11 mm long. Fruits are fleshy nutlets, four together, 6 mm long (Wagner *et al.* 1999). Phenology: Specimens in the HAVO Herbarium had flowers in the spring (May).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island. The species is distributed between 1,200 and 1,700 m (3,940–5,580 ft) elevation (Wagner *et al.* 1999) on windward Mauna Kea, windward and leeward Mauna Loa, and **Hualālai in North Kona District (Sherff 1935)**.

HAVO DISTRIBUTION: `Ōla`a Forest, Koa, and Ag units; known from only three localities in HAVO. Also planted at both Koa Unit and Small Tract in `Ōla`a Forest. Recently observed at Kahuku on both eastern and western slopes (not mapped).

HABITAT: Montane `ōhi`a lehua/hāpu`u wet forest.

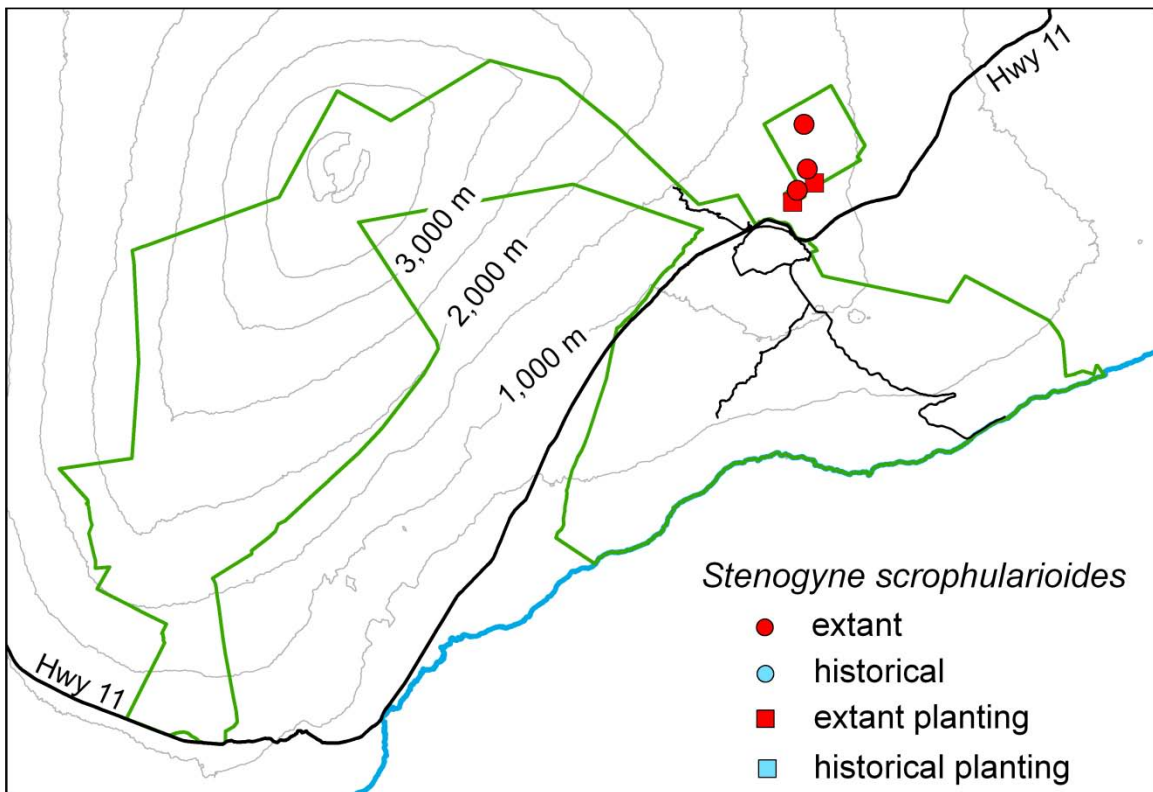
SIMILAR SPECIES: *Stenogyne macrantha* shares its rain forest habitat with two related species: *S. calaminthoides* and *S. scrophularioides*. *Stenogyne calaminthoides* has almost round, thick-textured, hairless leaves with truncate bases and large, pink to magenta flowers. *Stenogyne scrophularioides* has leaves much smaller than those of *S. macrantha*, and its pale greenish-yellow flowers are smaller and have a tubular calyx with short teeth.

THREATS: Feral pigs are a threat to the species in unprotected areas. Some factor appears to be limiting reproduction in the park, as plants are rarely observed bearing flowers or fruits. Pollinators may be missing, and slugs may be depredated Hawaiian mint seedlings.

MANAGEMENT/RESTORATION STRATEGIES: The montane wet forest supporting this species in HAVO has been fenced, and feral pigs have been removed. The worst invasive alien plants are controlled: **kāhili ginger**, banana poka, strawberry guava, and yellow Himalayan raspberry. Large-flowered Hawaiian mint was recently (2002–2003) propagated and planted in the park, where approximately 10 individuals were introduced **in each of Koa Unit and Small Tract of `Ōla`a Forest**. Plantings persisted with about 40% survival after seven years (Belfield *et al.* 2011). More intensive monitoring of known populations and research into reproduction and recruitment may be warranted for this species.

REMARKS: This species is very rare in HAVO and does not seem to be adequately reproducing and recruiting young plants. It is found in low numbers in adjacent lands north and east of the park, such as Pu`u Maka`ala Natural Area Reserve (Hawai`i Department of Land and Natural Resources 1989), **Keauhou Ranch, and Kūlani**. **There are no published monitoring data to indicate the stability of populations outside the park.**

CULTURAL USES/ETHNOBOTANY: None known.



Mōhihi, *Stenogyne scrophularioides*

Photo: Linda Pratt, USGS, PIERC

COMMON NAME: **Mōhihi**

SCIENTIFIC NAME: *Stenogyne scrophularioides*

FAMILY: Lamiaceae (Mint Family)

SYNONYMS: *Stenogyne biflora*, *S. hirsutula*; *S. macrantha* var. *amicarum*, *S. m.* var. *gracilis*; *S. nelsonii*, *S. scandens*; *S. scrophularioides* var. *biflora*, *S. s.* var. *nelsonii*, *S. s.* var. *remyi*, *S. s.* var. *skottsbergii*; *S. sororia*

FEDERAL AND STATE STATUS: No status (federal), Species of Concern (state of Hawai`i)

DESCRIPTION: Vine with round to four-angled stems, smooth or sparsely hairy. Leaves opposite, ovate to ovate-lanceolate, 2–8 cm long and ca. 2–5 cm wide, smooth or sparsely hairy, apex acute and base truncate or slightly heart-shaped; margins with teeth pointing forward; petiole 5–50 mm long, glabrous or sparsely hairy. Juvenile leaves are deeply lobed. Flowers are borne in whorls in axils of leaves at branch tips; 6–10 flowers per whorl, flower stalk 4–13 mm long, not hairy; calyx tubular or bell-shaped, 5–13 mm long, not hairy or with scattered hairs, with blunt or rounded calyx teeth 1–4 mm long; corolla pale yellow-green or magenta tinged with green, hairy on outside at base, tube curved or straight, 8–19 mm long, upper lip 4–8 mm long and lower lip 1–4 mm long. Fruits are fleshy nutlets, four together, 4–6 mm long, green when immature and shiny black when mature (Wagner *et al.* 1999). Phenology: Specimens in the HAVO Herbarium had flowers in the spring (March).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island, found primarily on Mauna Loa between 600 and 1,600 m elevation.

HAVO DISTRIBUTION: **`Ōla`a Forest, recently observed** at fewer than 20 sites in the Koa Unit, New Unit, and Small Tract (Pratt and Abbott 1997). **Also planted in `Ōla`a Koa Unit and Small Tract.**

HABITAT: Montane `ōhi`a lehua/hāpu`u wet forest.

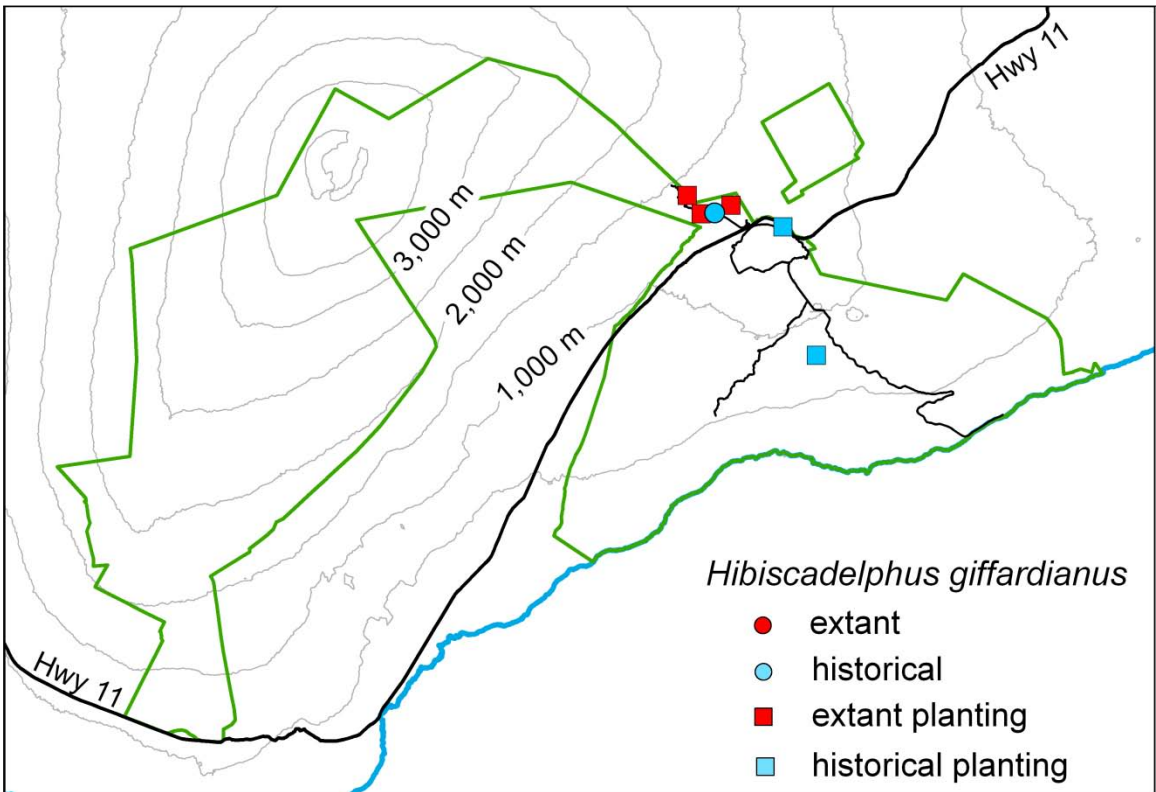
SIMILAR SPECIES: *Stenogyne macrantha* has larger, hairy leaves heart-shaped at the base and larger, more curved flowers that have a hairy calyx with long pointed teeth. *Stenogyne calaminthoides* has larger, thicker-textured leaves that are almost round and have a prominent truncate base; its flowers are larger and pink or magenta in color.

THREATS: Feral pigs are a threat to the species in unprotected areas. Pollinators are unknown, but plants have been observed bearing flowers and fruits. Highly invasive alien plants may displace this vine in some areas.

MANAGEMENT/RESTORATION STRATEGIES: **In the Koa Unit and Small Tract of `Ōla`a Forest, feral pigs** have been removed, and the most invasive plant species (same as for large-flowered Hawaiian mint) are being controlled. Recently (2002–2004) more than **90 mōhihi were planted in `Ōla`a, distributed** between Koa Unit and Small Tract. Few plants (<20%) persisted more than four to seven years, but survivors have been observed with flowers and fruits (Belfield *et al.* 2011).

REMARKS: Several previously recognized species and varieties (Sherff 1935) have been subsumed into *S. scrophularioides* (Wagner *et al.* 1999). The leaves of young plants are strongly divided or lobed, and they look very different from the entire or unlobed leaves of mature vines.

CULTURAL USES/ETHNOBOTANY: None known.



Hau kuahiwi, *Hibiscadelphus giffardianus*

Photos: Thane Pratt, USGS, PIERC, tree and fruit; Linda Pratt, USGS, PIERC, flower

COMMON NAME: **Hau kuahiwi**

SCIENTIFIC NAME: *Hibiscadelphus giffardianus*

FAMILY: Malvaceae (Hibiscus Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Endangered Species, listed in 1996

DESCRIPTION: Tree, to 12 m tall. Leaves large, nearly round, 10–25 cm long, hairy in angles of the veins, base heart-shaped; margins entire or with few teeth; petioles often as long as leaf blades. Flowers solitary on stalks of 1.5–3 cm, surrounded by five to seven narrow, spreading bracts 18–35 mm long; calyx ca. 3–4 cm long, two- to three-parted; corolla gray-green to magenta, 6–7 cm long, curved, covered with star-shaped hairs; stamens many, fused into column exerted from flower; style longer than column with five-lobed, red stigma. Fruits are woody capsules, oblong-ovoid in shape, 4–5 cm long and 2–2.5 cm wide, densely hairy, split open when mature. Seeds 7–10 mm long, soft tan hairs (Wagner *et al.* 1999). Phenology: Flowers seen throughout year, and fruit capsules are persistent (Pratt *et al.* 2010).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island, found **only at Kīpuka Puaulu** near 1,220 m (4,000 ft) elevation. A single tree was discovered here in 1911.

HAVO DISTRIBUTION: All park plants are the result of planting efforts at **Kīpuka Puaulu, Kīpuka Kī and Kīpuka `Aiea, a small forest northwest of Kīpuka Kī; formerly planted on a roadscar near park headquarters (Morris 1967) and at `Āinahou Ranch (N. Zimmer, unpublished data).**

HABITAT: Montane mesic forest of koa/`ōhi`a lehua/mānele. The site of the original tree was the edge of a collapsed lava tube on the southwestern edge of the kīpuka.

SIMILAR SPECIES: *Hibiscadelphus hualalaiensis*, native to Pu`uwa`awa`a in North Kona, is similar to *H. giffardianus*, but may be distinguished by its smaller greenish flowers with very short (<3 mm) bracts. Hybrids between the species have flowers and bracts of intermediate size.

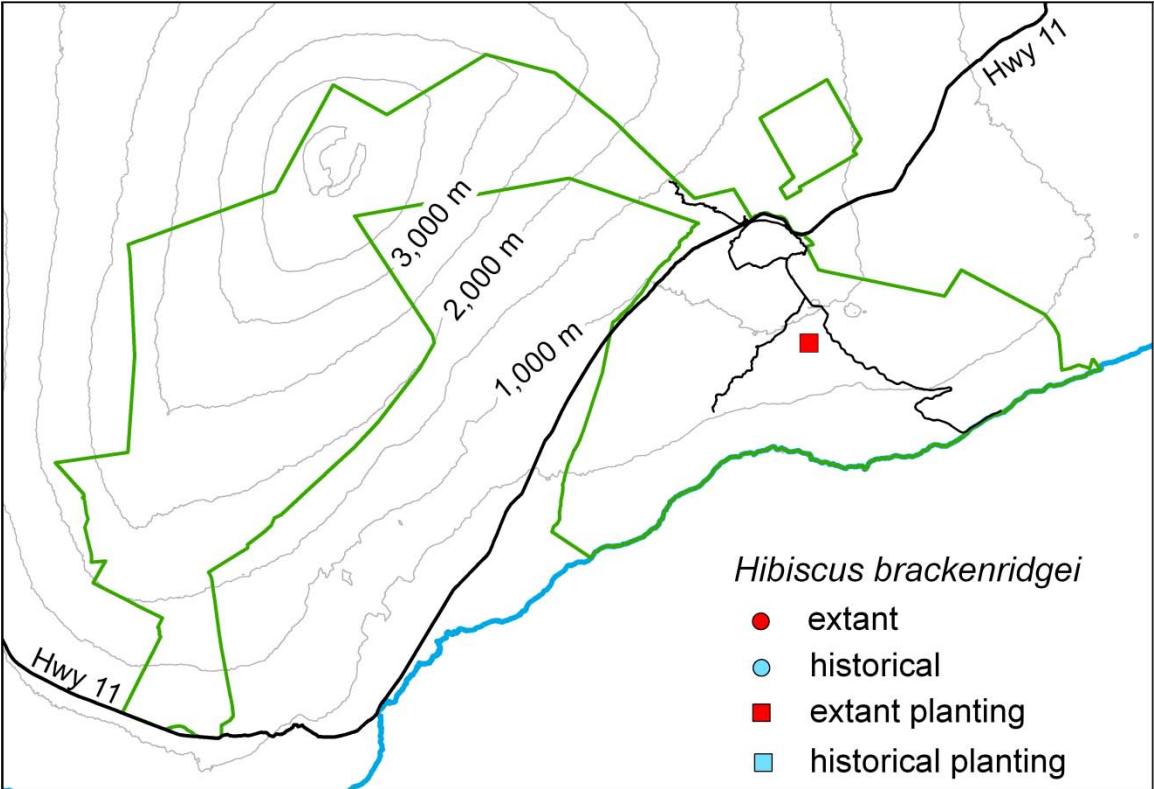
THREATS: Cattle, feral goats, sheep, and pigs were former threats to hau kuahiwi. Rats are seed predators, and they also strip **the tree's** bark and damage flowers. Fire is a potential threat. Persistent alien grasses may interfere with seedling recruitment. The introduced two-spotted leaf hopper attacks the foliage of hau kuahiwi. Most of the bird pollinators of hau kuahiwi are extinct. Self incompatibility is a suspected factor in the low reproductive rate (Pratt *et al.* 2010).

MANAGEMENT/RESTORATION STRATEGIES: Kīpuka Puaulu is intensively managed as a Special Ecological Area and invasive alien plants are controlled. Cattle were fenced out in 1930; feral goats and pigs were excluded in the 1960s. Hau kuahiwi exists today only because it was propagated by seed and cutting before the original tree died in 1930 (Degener 1975). Sixty trees were planted at HAVO in 1951–1964, but most died (Morris 1967). Later plantings at `Āinahou Ranch in 1974 did not persist (N. Zimmer, unpublished data). In 2002, <10 large trees remained in Kīpuka Puaulu. More than 300 hau kuahiwi seedlings were recently planted in Kīpuka Puaulu, Kīpuka Kī, and Kīpuka `Aiea, and the survival rate has been good (>70% after seven to eight years) (Pratt *et al.* 2010, Belfield *et al.* 2011). Additional plantings are planned for other mesic forest kīpuka (Loh 2008b). Hau kuahiwi would likely benefit from rat control in its habitat. Low fruit production due to poor self-compatibility and lack of native pollinators are difficult problems to address.

REMARKS: The past planting of both *H. giffardianus* and *H. hualalaiensis* in close proximity at **Kīpuka Puaulu and Kīpuka Kī led to unexpected hybridization. Unknowingly, hybrid trees were used as seed sources for propagation. When the hybrid nature of plantings was discovered in 1973, park managers removed the few *H. hualalaiensis* trees to arboreta and killed all known hybrids. Only the trees of pure *H. giffardianus* were left (Baker 1980). Recent plantings have been derived from seeds of park trees, descended from the original HAVO hau kuahiwi.**

CULTURAL USES/ETHNOBOTANY: None known.

Introduced to HAVO



Ma`o hau hele, *Hibiscus brackenridgei* subsp. *brackenridgei*
Photo: Keali`i Bio, Hawai`i Plant Extinction Prevention Program

COMMON NAME: **Ma`o hau hele**

SCIENTIFIC NAME: *Hibiscus brackenridgei* subsp. *brackenridgei*

FAMILY: Malvaceae (Mallow Family)

SYNONYMS: *Hibiscus brackenridgei* subsp. *molokaiana*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Shrub 1–3 m tall or a small tree 5 m tall. Leaf orbicular, 5–15 cm long and wide, shallowly to deeply lobed with three, five, or seven lobes; coarsely toothed; both surfaces smooth or with short hairs; base truncate to cordate; petiole more than half as long as blade. Flowers solitary or few with seven to ten linear-lanceolate bracts 8–22 mm long, often with stiff simple or branched hairs; calyx reddish to yellow, 1.5–4 cm long, lobed to middle, usually with stiff hairs, sometimes with glandular hairs; petals yellow, 3.5–8 cm long; staminal column exerted from flower with many anthers in the upper 3/4 of the column. Fruit a dry capsule, almost round or ovoid, beaked, 1–2 cm long, densely covered with long, soft or stiff hairs. Seeds angled and kidney-shaped, to 4.5 mm long, hairy (Wagner *et al.* 1999). Phenology: Flowers mostly in the winter and spring (U.S. Fish and Wildlife Service 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Distributed at low elevation of 130–800 m (425–2,625 ft) on all the main Hawaiian Islands, except Ni`ihau and Kaho`olawe (Wagner *et al.* 1999). On Hawai`i Island found naturally at Pu`uanahulu and near Waimea (U.S. Fish and Wildlife Service 1999). Widely planted as an ornamental.

HAVO DISTRIBUTION: Not native to HAVO, but planted at `Āinahou Ranch House.

HABITAT: The natural habitat of ma`o hau hele is lowland dry **forest and shrubland**. At `Āinahou, the shrub is planted in landscaped grounds near a building.

SIMILAR SPECIES: Other similar species planted as ornamentals at `Āinahou include hairy abutilon (*Abutilon grandifolium*) and egg hibiscus (*A. pictum*). Hairy abutilon has a heart-shaped leaf with a prominently pointed tip and flowers much smaller than ma`o hau hele and yellowish-orange instead of bright yellow. Egg hibiscus has a leaf with three narrow, pointed lobes and a nodding flower with yellow-orange petals that have prominent red veins (Staples and Herbst 2005).

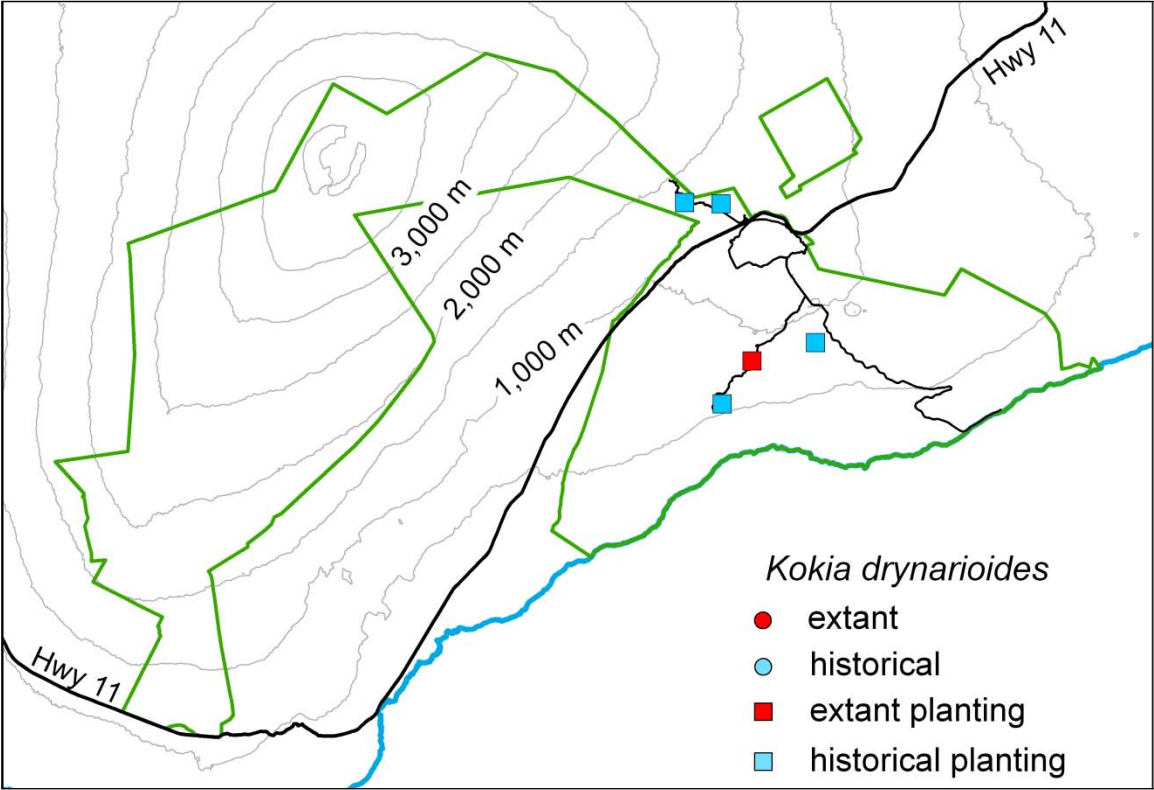
THREATS: In its natural habitat, ma`o hau hele is threatened by fire, feral ungulates, cattle, invasive alien plants, particularly grasses, and possibly rats (U.S. Fish and Wildlife Service 1999).

MANAGEMENT/RESTORATION STRATEGIES: As ma`o hau hele is not native to HAVO, restoration strategies may not be appropriate to the park. The species is an attractive ornamental and is hardy in **dry areas such as `Āinahou. It is unlikely to** spread or escape from cultivation at the site.

REMARKS: This species is the state flower of Hawai`i (Mehrhoff 1998).

CULTURAL USES/ETHNOBOTANY: The flowers of some native hibiscus were used as medicine by Hawaiians (Krauss 2001). The yellow flower of ma`o hau hele is beautiful and may have been used by Hawaiians for ornament. Today the ma`o hau hele is commonly used in landscaping (Staples and Herbst 2005).

Introduced to HAVO



Koki`o, Hau hele`ula, *Kokia drynarioides*
Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Koki`o, Hau hele`ula**

SCIENTIFIC NAME: *Kokia drynarioides*

FAMILY: Malvaceae (Hibiscus Family)

SYNONYMS: *Gossypium drynarioides*, *Hibiscus drynarioides*, *Kokia rockii*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1984

DESCRIPTION: Small tree, to 8 m in height. Leaves 8–20 cm wide, palmately seven- to nine-lobed, glossy green above, base of lower surface hairy, veins often red. Flowers large and showy, curved, with five red petals 10–15 cm long, stamens fused in a column, and an extended style with five red stigma. Fruits are woody, dehiscent capsules, 3 cm long, subtended by large, leaf-like, leathery, persistent bracts. Seeds are 12–15 mm long and are densely covered with tawny or brown hairs. Phenology: Summer-deciduous (Wagner *et al.* 1999). Flowers most heavily in early summer (Culliney and Koebele 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island, where it occurs naturally only **on the leeward slopes of Hualālai in North Kona** between 460 and 900 m (1,510–2,950 ft) elevation (Wagner *et al.* 1999).

HAVO DISTRIBUTION: Not native to HAVO. Between 1924 and 1958, approximately 150 koki`o were **planted in HAVO at Kīpuka Puaulu, Kīpuka Kī, Kīpuka Nēnē, Hilina Pali, and `Āinahou Ranch** (Morris 1967); only a single **tree at Kīpuka Nēnē persists**. Later plantings at `Āinahou in the 1970s are no longer present (N. Zimmer, unpublished data).

HABITAT: Native habitat is lowland to montane dry forest of lama, kauila, and other native trees, **including the endangered uhiuhi. Kīpuka Nēnē is a dry woodland of `ōhi`a lehua and māmane.**

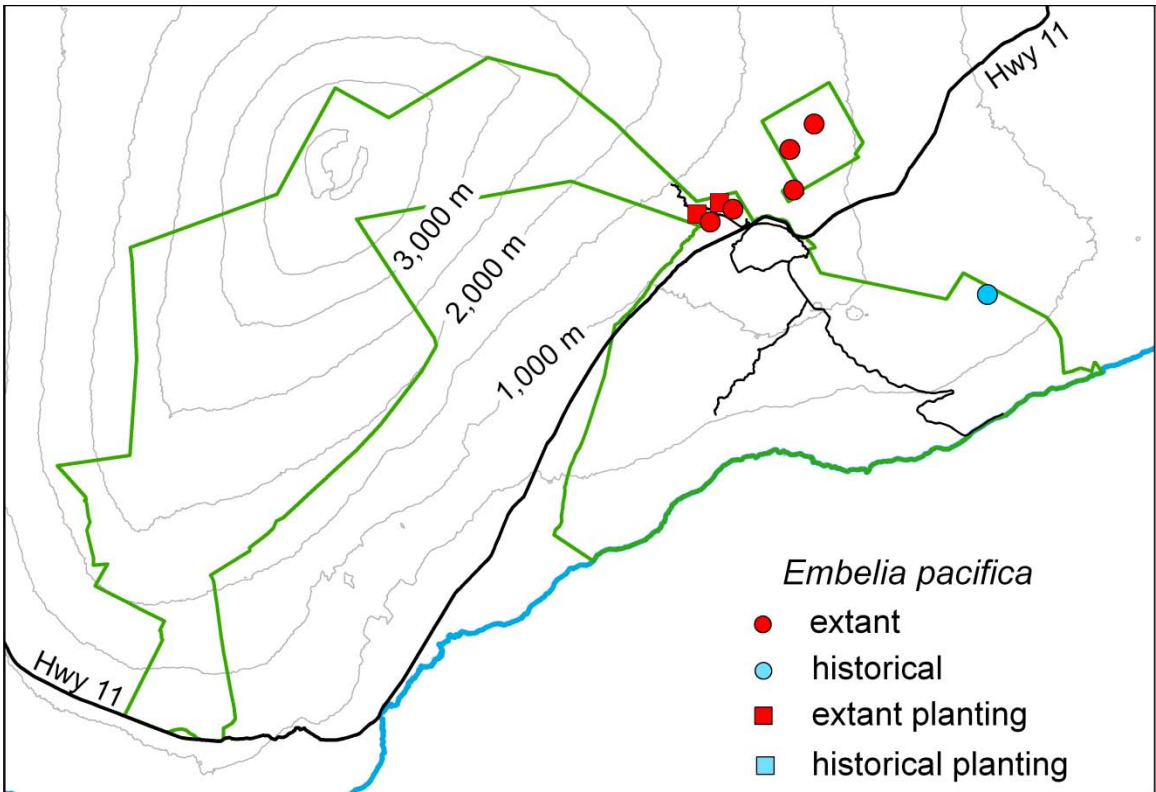
SIMILAR SPECIES: There is no other plant that closely resembles this koki`o, apart from the three other species of *Kokia*, which are endangered or extinct on the islands of Kaua`i (*K. kauaiensis*), O`ahu (*K. lanceolata*), and Moloka`i (*K. cookei*). Koki`o trees bear a slight resemblance to ornamental red *Hibiscus*, but differ from both native and alien *Hibiscus* in their star-shaped, lobed leaves, enormous twisted flowers, and capsules with large, leathery bracts.

THREATS: Fire is a serious threat to the few remaining trees in their natural habitat, since invasion of the fire-prone fountain grass. In the past, feral goats and domestic cattle browsed native trees of the dry forests of North Kona and interfered with tree reproduction and recruitment. Insects, such as rose beetles, are reported to attack koki`o leaves (Culliney and Koebele 1999).

MANAGEMENT/RESTORATION STRATEGIES: This species may be inappropriate for planting within **HAVO, an area outside its natural range. Plantings were removed from `Āinahou Ranch in 1980** (N. Zimmer, unpublished data), **and trees placed at Hilina Pali, Kīpuka Kī, and Kīpuka Puaulu apparently did not persist past 1985**. In 1995, two **trees were alive just north of Kīpuka Nēnē; only a single tree remains**. Seeds of this tree may be of use in a recovery program elsewhere on the island. Fires are suppressed in HAVO, and the remaining koki`o tree is within an alien plant control unit, which is free of feral goats and cattle.

REMARKS: The genus *Kokia* is endemic to the Hawaiian Islands, and the three extant species (each endemic to a single island) are exceedingly rare. The first collection of *K. drynarioides* was made by David Nelson at Kealakekua in 1779 (St. John 1976), but the species has been lost from that historical site.

CULTURAL USES/ETHNOBOTANY: Rock (1913) reported that Hawaiians stripped the bark of koki`o to make a brown dye, which they used to treat fish nets. Flower petals provided Hawaiians with a pink dye (Krauss 1993, Culliney and Koebele 1999).



Killioe, *Embelia pacifica*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Kilioe**

SCIENTIFIC NAME: *Embelia pacifica*

FAMILY: Myrsinaceae (Myrsine Family)

SYNONYMS: *Embelia hillebrandii*

FEDERAL AND STATE STATUS: No status, former Species of Concern

DESCRIPTION: Woody vine with prominent raised lenticels on bark. Leaves alternate, obovate to elliptic, 3.5–19 cm long and 1–10 cm wide, glossy, hairless, conspicuously dotted with dark glands (glandular punctate), margins entire in adult leaves and wavy-toothed in young leaves. Flowers unisexual and dioecious (sexes on different plants); flowers in axillary inflorescences 15–45 mm long; each flower with four to five ovate calyx lobes and four to five greenish, gland-dotted petals 3–4 mm long; Stamens present but non-functional in female flowers. Fruits are flattened, globose drupes, 7–11 mm in diameter, dark purple when ripe. Seed one per fruit, almost round (Wagner *et al.* 1999). Phenology: Not well studied, but fruits are infrequently seen.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Found on all the main Hawaiian Islands, except Ni`ihau and Kaho`olawe. Distributed in forests between 450 and 1,650 m (1,475–5,410 ft) elevation. Uncommon in montane forests of Hawai`i Island.

HAVO DISTRIBUTION: Naturally occurring in `Ōla`a Forest (Small Tract, Ag Unit, New Unit) (Pratt and Abbott 1997), Kīpuka Puaulu (Fosberg 1966), Kīpuka Kī, and formerly in the East Rift Special Ecological Area (Pratt *et al.* 1999). **Recently planted in Kīpuka Puaulu and Kīpuka Kī.**

HABITAT: Montane wet and mesic forests. The montane wet forests are dominated by `ōhi`a lehua and tree ferns, and the mesic kīpuka forests have a mixed canopy of koa, mānele, and `ōhi`a. The former habitat of kilioe on Kīlauea's East Rift is lowland wet forest of `ōhi`a lehua.

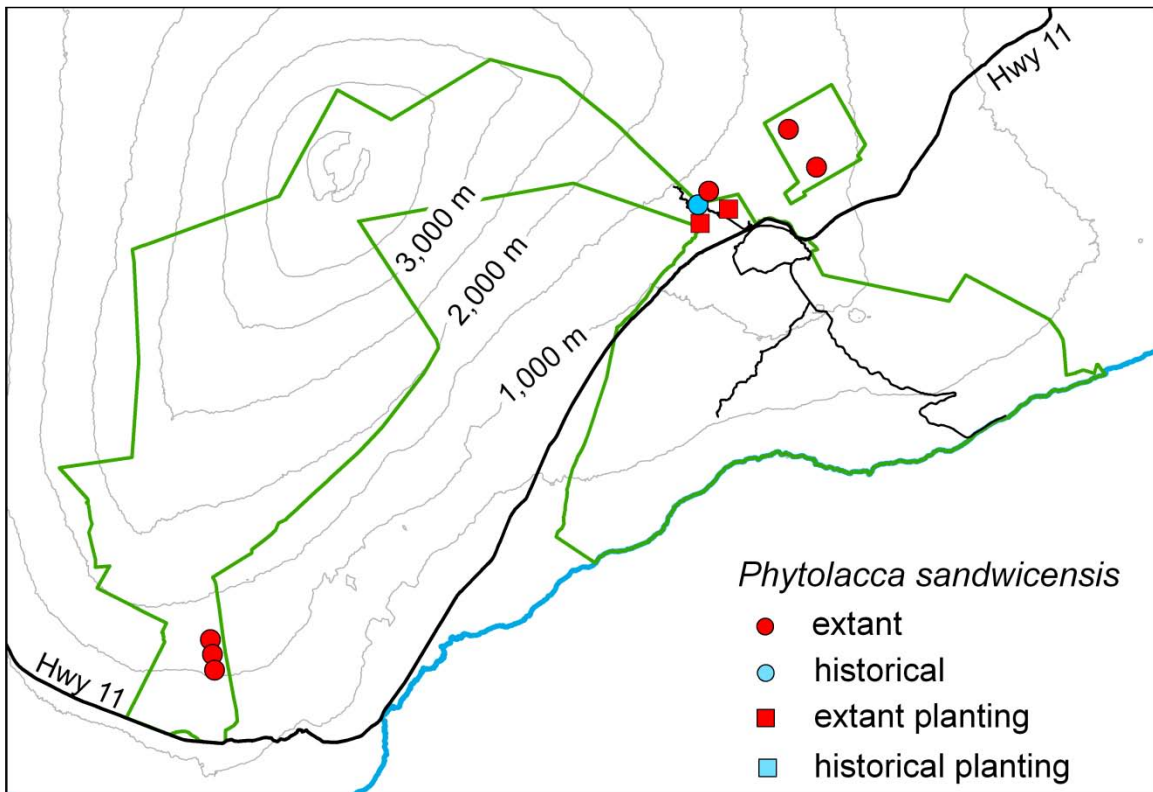
SIMILAR SPECIES: Kilioe, a vine, bears a resemblance to its tree relative **kōlea lāu nui** (*Myrsine lessertiana*), which is common in the understory of montane wet forests. Kilioe may be distinguished from kōlea by its twining habit as a vine, conspicuous bark lenticels, and more prominent netted venation on its leaves. Kilioe lacks the bright magenta young foliage so obvious on branch tips of kōlea lāu nui. Kilioe might also be mistaken for the common liana maile (*Alyxia stellata*), but the milky sap and whorled leaves of maile serve to distinguish it from the much rarer and unrelated kilioe.

THREATS: Feral pigs are a threat to understory species in unprotected rain forests. Rats and alien invertebrates are potential threats to kilioe. The pollinator of the species is unknown, and reproductive success has not been monitored.

MANAGEMENT/RESTORATION STRATEGIES: Most of the habitat of kilioe in HAVO is now free of feral pigs. The vine was recently (2001–2003) propagated from seeds and cuttings, and more than 40 were **planted in Kīpuka Puaulu and Kīpuka Kī combined**; survival of plantings was good (>60%) after three years (Belfield *et al.* 2011). Kilioe is one of the rare species targeted for restoration to the East Rift and **Nāhuku (Thurston Lava Tube) Special Ecological Areas (Loh 2008a)**. **The impacts of rats have not been monitored for the park's kilioe. Research** into pollination and breeding biology of the species may be useful to managers.

REMARKS: Because this species is distributed on six islands and occurs in protected forests on Maui (**Haleakalā National Park**) (Medeiros *et al.* 1998) as well as at HAVO, it is unlikely that it will be raised to a species of concern or candidate for listing as an endangered species.

CULTURAL USES/ETHNOBOTANY: None known.



Pōpolo kū mai, *Phytolacca sandwicensis*

Photos: Thane Pratt, USGS, PIERC

COMMON NAME: **Pōpolo kū mai**

SCIENTIFIC NAME: *Phytolacca sandwicensis*

FAMILY: Phytolaccaceae (Pokeweed Family)

SYNONYMS: *Phytolacca brachystachys*, *P. b.* var. *puberulenta*; *P. sandwicensis* var. *puberulenta*

FEDERAL AND STATE STATUS: No status (federal), Species of Concern (state of Hawai`i)

DESCRIPTION: Large sprawling herb, woody at the base. Stems angular and usually hairy. Leaves fleshy elliptic-ovate to oblong elliptic, 8–22 cm long and 4–10 cm wide, smooth or hairy, particularly along veins, margins undulating, apex acute or acuminate, base cuneate, petiole <1–5 cm long. Flowers borne on racemes 8–22 cm long with a stalk (peduncle) of 2–4 cm. Flowers are usually covered with fine short hairs and have flower stalks 3–5 mm long; five pink sepals, 3–4 mm long; stamens seven to nine; and ovary with five to seven sections (carpels). Fruit a berry, dark purple when ripe, 4–6 mm diameter, with five to seven sections delineated by longitudinal ribs or grooves. Seeds are black, almost kidney-shaped, wrinkled, and 3 mm long (Wagner *et al.* 1999). Phenology: Specimens in the HAVO Herbarium bore flowers or fruit from March to October.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Kaua`i, O`ahu, Moloka`i, Maui, and Hawai`i, between 680 and 1,980 m (2,230–6,490 ft) elevation.

HAVO DISTRIBUTION: `Ōla`a Forest in the Koa and Pu`u units. Known historically from Kīpuka Kī (Fosberg 1966) and extant at a small kīpuka north of Kīpuka Kī (Belfield *et al.* 2011). Planted in Kīpuka Puaulu and Kīpuka Kī. Also found in central Kahuku Unit.

HABITAT: Lowland or montane mesic to wet forest. In HAVO, pōpolo kū mai occurs in montane wet forest of `ōhi`a lehua and hāpu`u, as well as in montane mesic forest of koa, `ōhi`a lehua, and mānele. On other islands, the species is found along streambeds and in forests at lower elevation (Wagner *et al.* 1999).

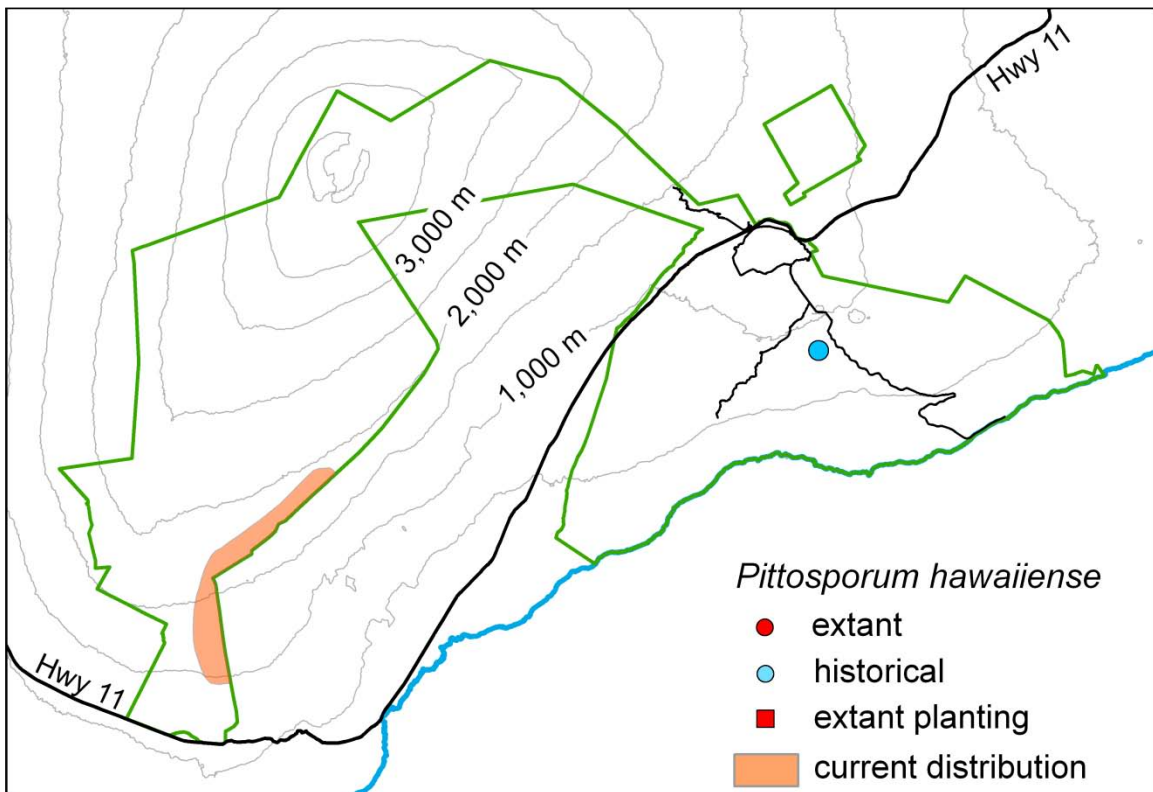
SIMILAR SPECIES: No other native plants closely resemble pōpolo kū mai. An alien pokeweed is found in Hawai`i, but has not been observed in HAVO. The southern pokeberry (*Phytolacca octandra*) has stems and leaves usually less hairy than pōpolo kū mai, smaller flowers with short stalks (0.5–2 mm long), and berries with seven to eight (or more) sections (Wagner *et al.* 1999).

THREATS: Feral pigs and other feral ungulates are threats in unprotected habitat. Invasive alien plants, such as yellow Himalayan raspberry, strawberry guava, and kāhili ginger may displace pōpolo kū mai. Pollinators and seed dispersal agents are unknown. The impacts of non-native rats and slugs have not been studied.

MANAGEMENT/RESTORATION STRATEGIES: The wet forest habitat of pōpolo kū mai is protected within managed units of `Ōla`a Special Ecological Area, where feral pigs have been removed and the most invasive alien plants are controlled. The mesic forest habitat of the species is within Kīpuka Puaulu, Kīpuka Kī, and a small kīpuka between them; all these sites are considered SEAs, are free of feral ungulates, and have the most invasive alien plants controlled within them. Because pōpolo kū mai was lost from Kīpuka Kī, plants were restored there and at Kīpuka Puaulu in 2002; although survival was variable (15–50%), some plants persisted more than two years (Belfield *et al.* 2011). Plantings are planned for three small kīpuka (Boundary Kīpuka SEA) on the park boundary northwest of Kīpuka Puaulu (Loh 2008b) and for protected areas at Kahuku (McDaniel *et al.* 2008). Research on the impacts of rats on seeds of this species and the impacts of slugs on seedlings may provide information useful to managers.

REMARKS: Pōpolo kū mai may be naturally short-lived; many plants mapped in `Ōla`a Forest in the 1990s (Pratt and Abbott 1997) could not be found 10 years later (Belfield *et al.* 2011).

CULTURAL USES/ETHNOBOTANY: The berries of pōpolo kū mai are reported to have been used by Hawaiians for dye (Pukui and Elbert 1971).



Hō`awa, *Pittosporum hawaiiense*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Hō`awa, Hawai`i hō`awa**

SCIENTIFIC NAME: *Pittosporum hawaiiense*

FAMILY: Pittosporaceae (Pittosporum Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Small tree, to 4 m tall; young branch tips densely covered with brown or reddish-brown hairs. Leaves alternate, thick in texture, oblong-obovate; 15–28 cm long and 3–8 cm wide; with prominent reticulate venation; upper surface glossy with impressed veins; lower surface covered with brown to reddish-brown hairs; margins entire, with slightly rolled edges; petioles 2–4 cm long. Flowers unisexual in axillary inflorescences of 8–10 flowers; inflorescence stalk (peduncle) 4–12 mm long, stout; calyx with five distinct sepals 3.5–5 mm long; flowers cream-colored, 13–18 mm long; male flowers have five stamens with filaments 8–9 mm long and anthers almost 4 mm long; female flowers with non-functional stamens 4–5 mm long and small sterile anthers, ovary of two sections. Fruits are woody two-valved capsules 24–38 mm long, cuboid-ovoid in shape, brownish hairy when young, with a persistent style 2–5 mm at end; wall of capsule 3–8 mm wide, strongly wrinkled or sculptured on outside. Seeds about 30 per capsule, not filling inside of fruit; black to reddish-black and shiny, irregular in shape, 7–10 mm long (Wagner *et al.* 1999). Phenology: Unknown, but capsules are likely persistent for long periods.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to leeward Hawai`i Island; distributed from **Kohala to Ka`ū District between the elevations of 520 and 1,830 m (1,710–6,000 ft)**. In the past, this **hō`awa was most common in forests above Na`alehu in Ka`ū (Rock 1913)**.

HAVO DISTRIBUTION: Kahuku Unit, scattered in **wet to mesic forests west and north of Ka`ū Forest Reserve**, from about 800 to 1,700 m (2,625–6,460 ft) elevation. **Reported from `Āinahou Ranch**, where the current status of the species is uncertain.

HABITAT: Montane mesic to wet forest of `ōhi`a lehua and koa.

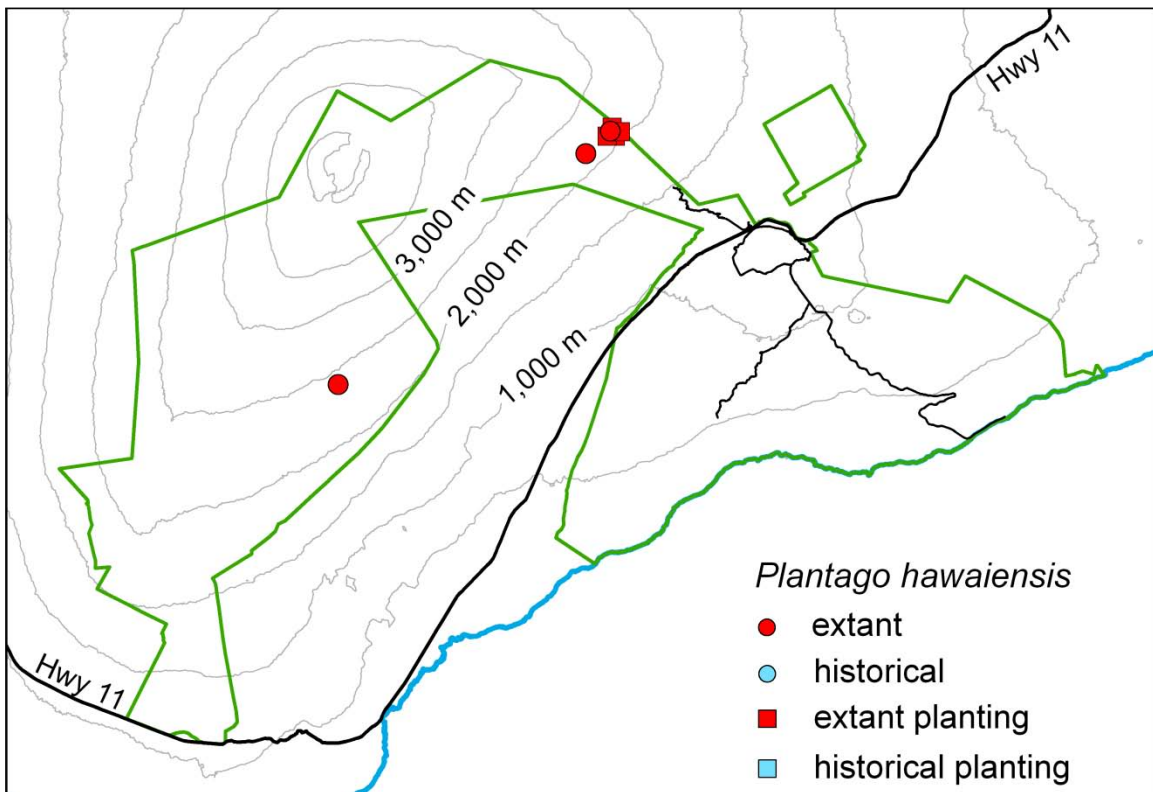
SIMILAR SPECIES: *Pittosporum hawaiiense* is similar in appearance to *P. hosmeri*, from which it differs in having smaller fruiting capsules (<3.8 cm) with a sculptured surface (Haas 1977). The leaves of *P. hawaiiense* are usually broader and have prominent reticulate leaf venation.

THREATS: Domestic stock (cattle and horses), feral goats, feral sheep, and mouflon sheep strip bark of **hō`awa, threatening the survival of even large trees. Such animals also interfere with recruitment of young trees. Rats are known seed predators of several species of hō`awa (Benitez *et al.* 2008)**.

MANAGEMENT/RESTORATION STRATEGIES: Hō`awa will likely benefit from mouflon sheep reduction and feral animal control, which has begun at Kahuku Unit. The species is being propagated for planting in Kahuku exclosures and is a good candidate for augmentation in future ungulate-free areas at Kahuku (S. McDaniel, pers. comm.). Currently one block at `Āinahou Ranch is managed as a Special Ecological Area and receives alien plant control and protection from fire. If this hō`awa is confirmed as a natural component of `Āinahou Ranch, sites for re-introduction could be selected in woodlands there. The feasibility of protecting hō`awa from seed-predating rats has not been studied.

REMARKS: Harold St. John identified a fragmentary specimen **from `Āinahou** as this species, but the sheet included little fertile material and may have represented *P. terminalioides*, a species known to occur in the area (HAVO Herbarium). While the presence of *Pittosporum hawaiiense* **at `Āinahou is unconfirmed, the species has been recently collected in `Ōla`a Forest Reserve, adjacent to `Ōla`a Forest (HAVO Herbarium)**.

CULTURAL USES/ETHNOBOTANY: Krauss (1993) reported that the wood of some species of hō`awa was used in canoes.



Laukāhi kuahiwi, *Plantago hawaiiensis*
Photo: Thane Pratt, USGS, PIERC

COMMON NAME: **Laukāhi kuahiwi**

SCIENTIFIC NAME: *Plantago hawaiensis*

FAMILY: Plantaginaceae (Plantain Family)

SYNONYMS: *Plantago gaudichaudiana*, *P. hawaiensis* var. *laxa*, *P. pachyphylla* var. *hawaiensis*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Perennial herb with a thick, wooly stem. Leaves thick, narrowly elliptic to lanceolate, 7.5–22 cm long and 1.5–3 cm wide, with five to seven almost parallel veins, hairless to sparsely hairy along margins; margins with fine teeth near the tip; petiole winged, 0–9 cm long. Flowers borne on spikes with stalks 20–90 cm long; flowers crowded on stalk, particularly near top; tiny, hairy bracts below each flower; sepals elliptic-ovate 1.6–2.2 mm long, unequal; corolla lobes spreading, ca. 1 mm long. Fruits are tiny capsules, oblong-ellipsoid in shape, 2.6–4 mm long, extended beyond the calyx, partially dehiscent. Seeds four to six per fruit, dull black, ca. 1 mm long, partly winged (Wagner *et al.* 1999). Phenology: Flowers and fruits have been seen in all seasons.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island; upper leeward slopes between 1,800 and 2,135 m (5,900–7,000 ft) elevation.

HAVO DISTRIBUTION: Mauna Loa Strip; concentrated in two **populations in Kīpuka Kulalio and Kīpuka Mauna`iu** at 2,135 m (7,000 ft) elevation (Belfield and Pratt 2002); small groups of plants have been **observed below a fence at 2,070 m (6,800 ft) elevation in Kīpuka Kulalio. Kahuku Unit, in subalpine zone north of Ka`ū Forest (Benitez *et al.* 2008).** Also planted in exclosures in the upper Mauna Loa Strip.

HABITAT: Subalpine dry shrublands, sometimes on lava.

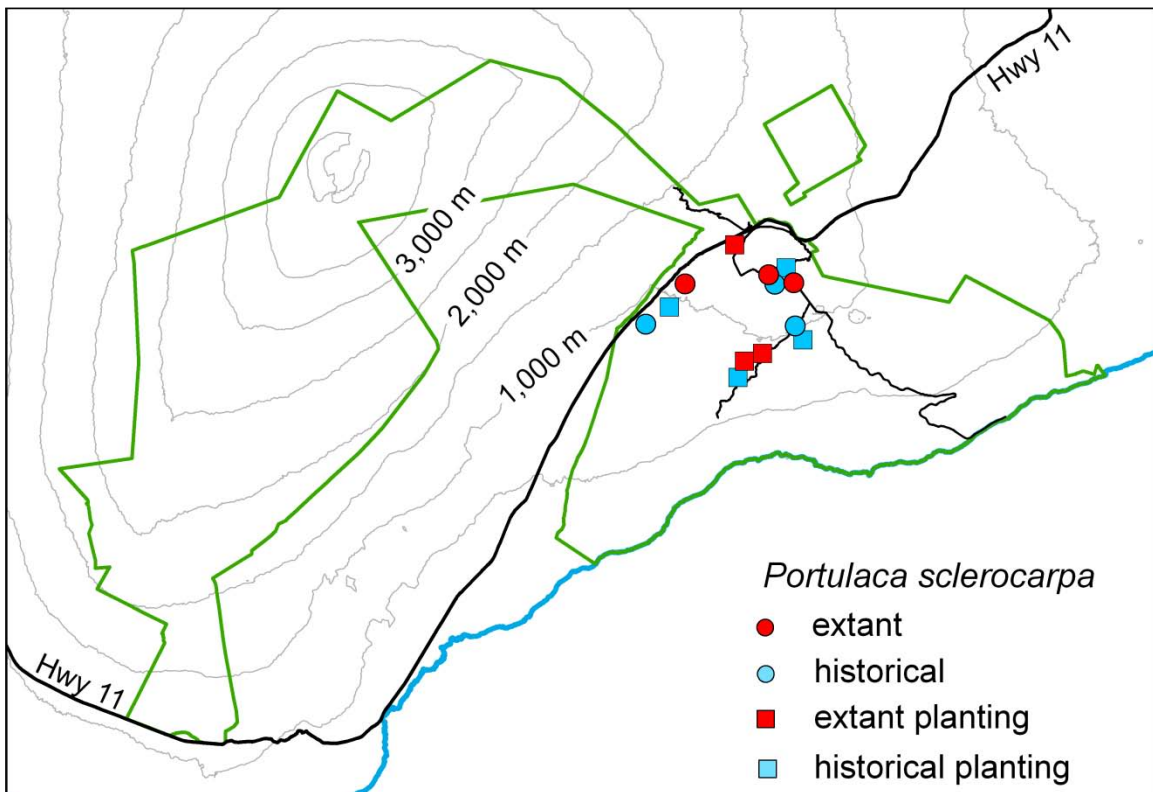
SIMILAR SPECIES: *Plantago hawaiensis* is very similar to *P. pachyphylla*, an uncommon species found in wet montane and subalpine habitats that has been reported from HAVO only once (Kahuku). The endangered *P. hawaiensis* has smaller sepals (<2.2 mm long) and capsules extending beyond the calyx, while *P. pachyphylla* has larger sepals 2–4 mm long and capsules covered by the calyx or only slightly exposed (Wagner *et al.* 1999).

THREATS: Feral goats, sheep, and mouflon sheep **may threaten the rare laukāhi kuahiwi, although signs** of severe browsing have not been noted in HAVO. Feral pigs may uproot plants in unprotected areas. Alien plants may compete for resources and seedling sites. Natural perturbations, such as flooding and droughts, reduce already small populations.

MANAGEMENT/RESTORATION STRATEGIES: An exclosure has been built around the declining population **at Kīpuka Kulalio and seedlings were planted** there. Other planting sites are a silversword restoration exclosure below the 2,070 m cross-fence and a site along the Mauna Loa Trail. A total of >200 plantings **augmented the laukāhi population, and almost half survived** nine years (Belfield *et al.* 2011). The species is not difficult to propagate, and additional restoration sites are available. Both alpine and lower units of Mauna Loa SEA are protected from feral goats, pigs, and incursions of mouflon sheep. Few alien plants have significant cover in subalpine habitat. Mouflon sheep populations are being reduced at Kahuku, but **the laukāhi kuahiwi population there may require additional management for** its long-term persistence. Research may be required to determine the cause of losses.

REMARKS: A recent study of the two **main populations of laukāhi kuahiwi** in HAVO revealed that the **Kīpuka Mauna`iu concentration was maintaining its numbers, despite years of severe drought, periodic spring floods, and the presence of feral ungulates** (Belfield and Pratt 2002).

CULTURAL USES/ETHNOBOTANY: It is uncertain whether this species was used medicinally, as is the **introduced common plantain, also known as laukāhi (Krauss 2001).**



ʻIhi mākole, Po`e, *Portulaca sclerocarpa*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **`Ihi mākole, Po`e**

SCIENTIFIC NAME: *Portulaca sclerocarpa*

FAMILY: Portulacaceae (Purslane Family)

SYNONYMS: Geesink (1969) placed this species in *P. pilosa* var. *villosa*.

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Succulent perennial herb with a tuberous taproot; prostrate with weakly ascending branches; to 20 cm long. Leaves pale green, linear, succulent, 8–12 mm long and 1.5–2.5 mm wide, sessile with no petiole, with a tuft of yellow-brown hairs 3–6 mm long in the leaf axils. Flowers three to six in terminal clusters; two green and magenta sepals, 5 mm long; five white petals, obovate, 10 mm long; stamens 30, yellow, clustered in center of flower; style central in flower, eight-branched. Fruits are broad ovoid capsules 4–4.5 mm long, with thick walls, indehiscent or opening 1/3 from the base. Seeds are tiny, dark-reddish brown, glossy, with a rough-patterned surface (Wagner *et al.* 1999). Phenology: Flowers and fruits throughout the year.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Found on Hawai`i Island at elevations of 1,030–1,630 m (3,380–5,350 ft), **on an islet off Lāna`i (Wagner *et al.* 1999)**, and recently reported from Maui. Known from 11 populations on Hawai`i Island (U.S. Fish and Wildlife Service 1996).

HAVO DISTRIBUTION: A geothermal area near Puhimau Crater has the largest known population, although it is rapidly declining. Scattered individuals occur **in cinder fields near Keanakāko`i Crater and in the Ka`ū Desert. Formerly observed along upper Hilina Pali Road, near Ko`oko`olau Crater, and near Ka`ū Desert Trail. Plantings were recently (1998–2008) made at two sites on Kalanaoquaiki Pali, at two other sites near Hilina Pali Road, at the edge of Ke`āmoku Flow near Ka`ū Trail, along Crater Rim Trail near Hawaiian Volcano Observatory, and on the trail near Chain of Craters Road.**

HABITAT: Montane dry woodlands and cinderfields; in HAVO also occurs near steam vents.

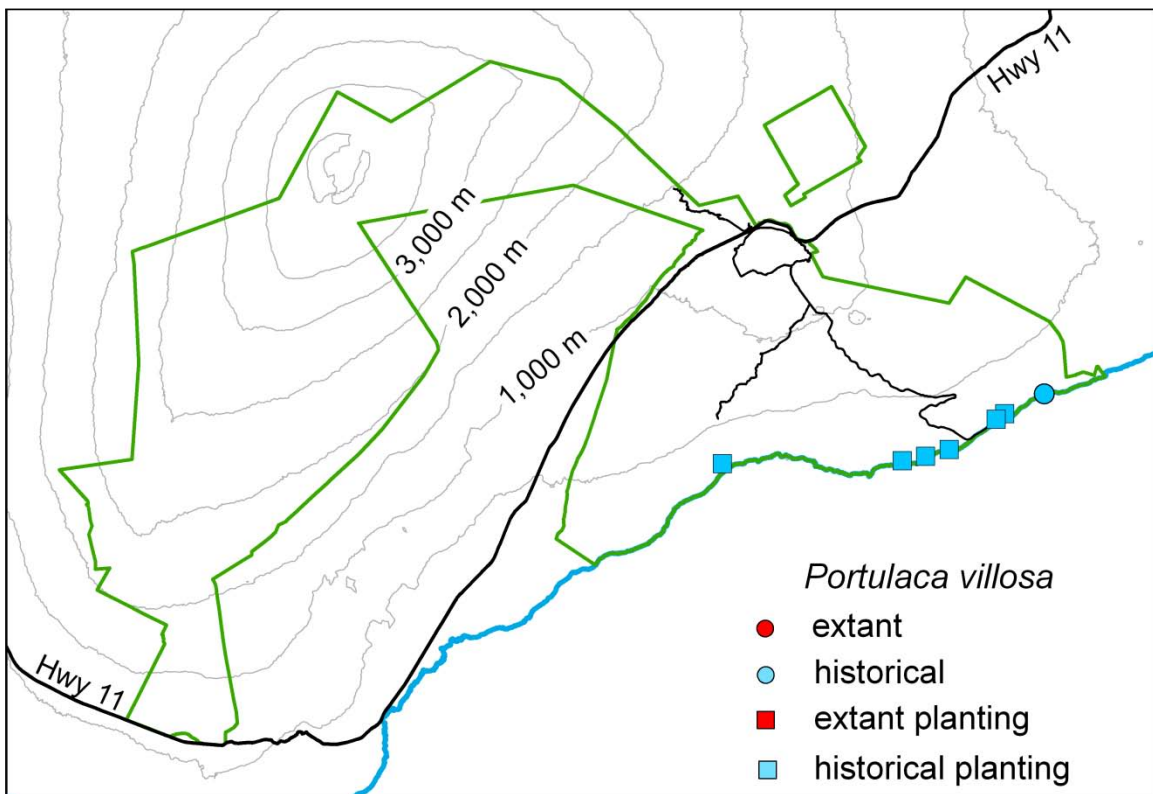
SIMILAR SPECIES: *Portulaca sclerocarpa* is similar to *P. villosa*, from which it differs in having thick-walled, indehiscent capsules and white flower petals lacking notches or any pink tinge. The native *Portulaca* species are larger and more robust plants than are the alien *P. pilosa* plants that share their habitat. The flowers of *P. pilosa* are dark pink or magenta, and its capsules are tiny.

THREATS: Feral goats may browse or trample the species in unprotected areas. Alien grasses may **displace `ihi mākole, and fire is a potential threat. Rodents have recently been implicated as destroyers of fruit capsules, and seedling recruitment is very low (Pratt *et al.* 2011).**

MANAGEMENT/RESTORATION STRATEGIES: **The habitat of `ihi mākole in HAVO is free of feral goats, and wildfires are suppressed. There is no effective control for the alien grasses that have invaded dry woodlands, such as broomsedge. `Ihi mākole is easily propagated, and >2000 plants were returned to former habitat near Hilina Pali Road and the Ka`ū Desert Trail, and at two new sites near Crater Rim Trail. Survival was initially good, but few plants (<1%) persisted six years (Belfield *et al.* 2011). A 2006–08 planting of >100 seedlings and cuttings at Kalanaoquaiki and the Mauna `Iki Trail has persisted for two to four years (Pratt *et al.* 2011). Rodent control may be necessary at plantings.**

REMARKS: HAVO supports the **state's largest known population at Puhimau. However, the site may be unstable geologically and is also subject to human use. The population of >4,000 `ihi mākole at Puhimau decreased 75% between 1984 and 1994, when less than 1,000 plants were counted (L. Pratt, unpublished data). During recent monitoring, only 300 plants were found (Pratt *et al.* 2011). Fosberg (1966, p. 190) reported that the species was "frequent in transition between forest and desert" prior to the invasion of fire-adapted alien bunchgrasses.**

CULTURAL USES/ETHNOBOTANY: None known specific to the rare species. There are medicinal uses for `ihi, including other *Portulaca* and *Oxalis corniculata* (Krauss 2001).



Ihi, *Portulaca villosa*
Photos: Linda Pratt, USGS, PIERC

COMMON NAME: `Ihi

SCIENTIFIC NAME: *Portulaca villosa*

FAMILY: Portulacaceae (Purslane Family)

SYNONYMS: *Portulaca caumii*, *P. hawaiiensis*, *P. pilosa* var. *villosa*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Succulent perennial herb with a tuberous taproot; prostrate with weakly ascending branches; to 30 cm long. Leaves pale green, linear and succulent, 5–25 mm long and 1.5–3 mm wide, sessile with no petiole, with a tuft of yellow-brown hairs in the leaf axils. Flowers three to six in terminal clusters with dense tufts of hairs; two green sepals 4–5 mm long; five white to pink petals, obovate, 8–10 mm long, with a notched apex; stamens 18–50, yellow, clustered in center of flower; style central in flower, five- to seven-branched. Fruits are ovoid capsules 3–5 mm long, with thin walls, opening from near the base. Seeds are tiny, dark-reddish brown with a rough-patterned surface (Wagner *et al.* 1999). Phenology: Kim and Carr (1990) reported that Hawaiian *Portulaca* flower and fruit throughout the growing season, and plants are able to produce flowers at six to eight months of age.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Found on all the main Hawaiian Islands, except Ni`ihau and Kaua`i; at coastal and low elevation sites to 300 m (985 ft). Also reported from Pōhakuoa Training Area near 1,710 m (5,600 ft) elevation on Hawai`i Island (Shaw 1997).

HAVO DISTRIBUTION: Originally known from only one coastal site 1 km west of Kamoamoā; destroyed by lava in 1993. Plants were salvaged from the park population, and their progeny were planted at five sites along the HAVO coast: Lae`Apuki near Hōlei Sea Arch (two plantings), Ka`ena Point, Kealakomo makai, Kahue, and Ka`aha (Belfield *et al.* 2011). Plantings were unsuccessful, and the species may be extirpated from HAVO.

HABITAT: In HAVO, this `ihi has been found **only near the coast, growing in shallow ash over pāhoehoe**. Vegetation in these coastal communities is a mixture of the native sedge mau`u`aki`aki and alien plants, such as crabgrass.

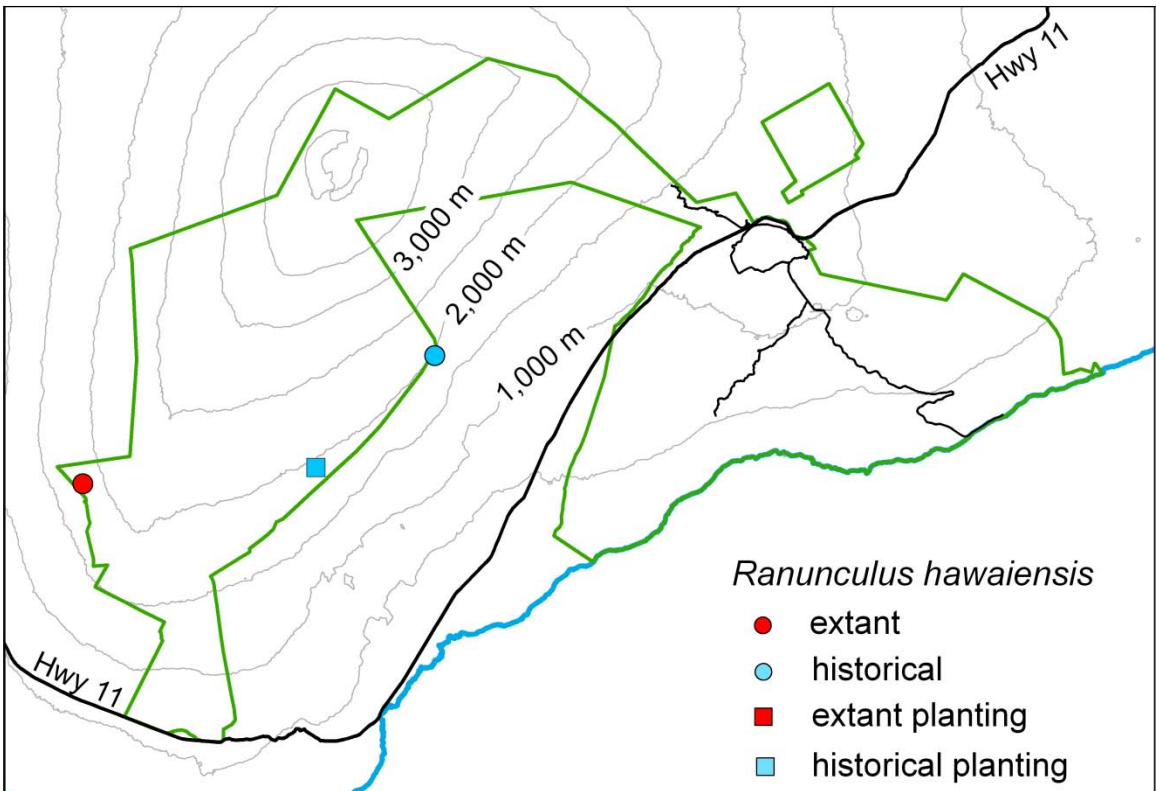
SIMILAR SPECIES: *Portulaca villosa* most closely resembles the endangered white-flowered *P. sclerocarpa* of higher elevations and the alien pink-flowered *P. pilosa*, which shares its coastal lowland habitat. *Portulaca villosa* may be distinguished from *P. sclerocarpa* by its thin-walled capsules opening near the base and flowers with notched petals that are sometimes pink-tinged, particularly near the base. *Portulaca villosa* differs from *P. pilosa* in both floral and leaf characters. *Portulaca pilosa* has dark pink to magenta flowers that are smaller than those of *P. villosa*, and its leaves are typically less rounded and turgid than those of *P. villosa*. The leaves of *P. pilosa* are often red-tinged rather than the characteristic pale green color of *P. villosa*.

THREATS: Alien grasses and wildfire are potential threats. Feral goats were formerly threats to native plants in the coastal lowlands. Seed predation by rodents is suspected.

MANAGEMENT/RESTORATION STRATEGIES: The coastal lowlands in HAVO are free of feral goats, and wildfires are suppressed. The species was introduced to five coastal sites as part of a coastal vegetation restoration project; plantings of >2,500 individuals did not persist more than 7–12 years. Because plants produced seeds, new plants may eventually re-appear (Belfield *et al.* 2011).

REMARKS: The rarity of this species in HAVO is not understood. Seemingly appropriate habitat exists at a number of park sites. The nearest known populations outside HAVO are Ka`alu`alu and points east of South Point. Like most Hawaiian *Portulaca*, the species is capable of self-fertilization and does not require insect agents for pollination (Kim and Carr 1990).

CULTURAL USES/ETHNOBOTANY: None known specific to the rare species.



Makou, *Ranunculus hawaiensis*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Makou**

SCIENTIFIC NAME: *Ranunculus hawaiiensis*

FAMILY: Ranunculaceae (Buttercup Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: Perennial herb, 5 to 20 cm tall with fibrous roots; stems are densely hairy with golden or whitish hairs. Basal leaves are twice ternately compound (leaflets in groups of three), leaflets lanceolate to ovate 5–7 cm long and 4–7 cm wide, terminal leaf is largest, irregularly toothed and lobed. Flowers are numerous in branched open cymes; receptacle conical; five yellowish green sepals, lanceolate to ovate, ca. 5.5–8 mm long, reflexed; petals, 5–10, yellow and glossy on upper surface, obovate 7–10 mm long. Fruits are achenes numerous in ovoid heads ca. 5 mm long, margined with a narrow wing, the faces conspicuously pitted, and beak straight or slightly curved, 0.9–1.2 mm long (Wagner *et al.* 1999). Phenology: Flowers in the summer or fall.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Rare in mesic forests and open pastures from 1,820 to 2,040 m elevation (5,970–6,700 ft), on East Maui and Hawai`i Island. This species is occasionally found at higher elevations (to 2,590 m or 8,500 ft).

HAVO DISTRIBUTION: Currently known in a single small population of less than 10 plants in the western Kahuku Unit of the park. A recent (2007) planting in the eastern Kahuku Unit failed.

HABITAT: Montane or subalpine mesic forest, on grassy or rocky slopes, and in open pastures (Wagner *et al.* 1999). At HAVO observed growing on rocky substrate in montane koa (*Acacia koa*) forests.

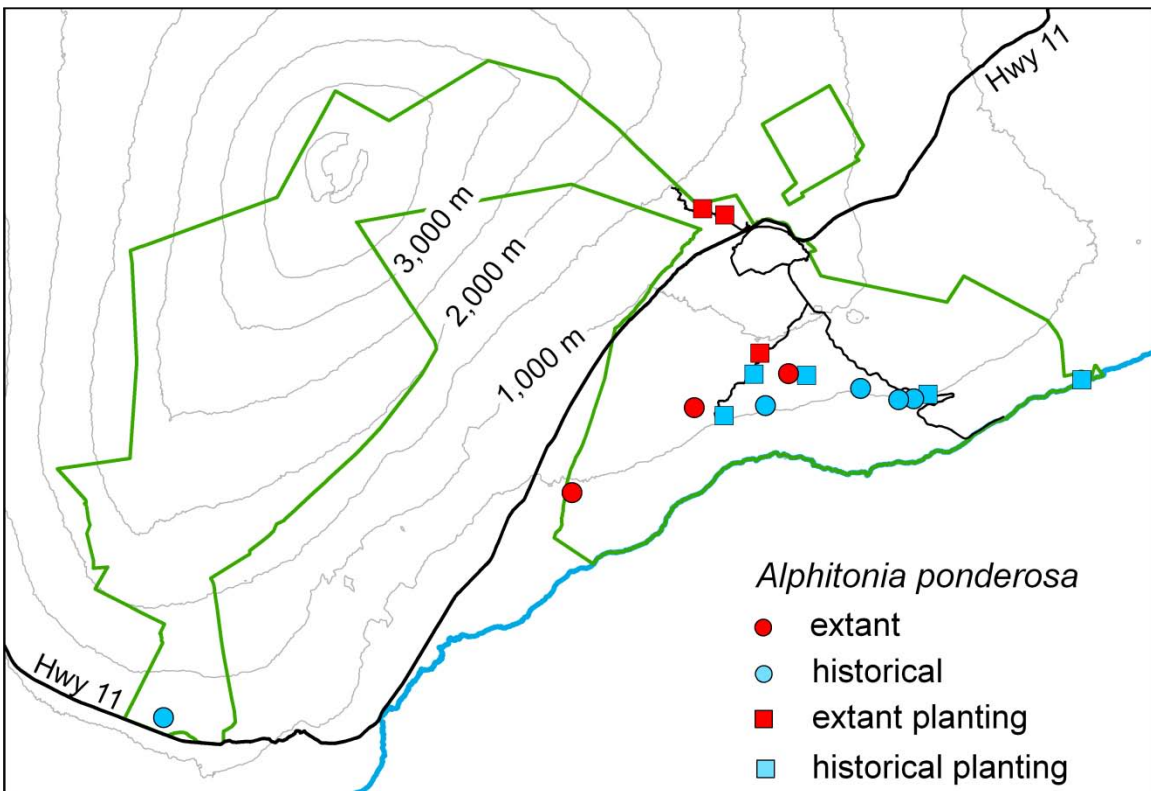
SIMILAR SPECIES: There is another native buttercup on Hawai`i Island, but it is not found in HAVO. *Ranunculus mauiensis* has sparse, flattened (appressed) hairs on its stems, few flowers with small petals, and leaves only once compound. Its fruits are about half the size of those of *R. hawaiiensis*. On Maui where both species occur, there may be hybrid plants (Wagner *et al.* 1999). There are four alien buttercups or *Ranunculus* species in Hawai`i, but none is known to occur at Kahuku Unit. They can be generally distinguished from native species by their less robust appearance and occurrence at lower elevations. The common Australian buttercup (*R. plebeius*) is found in upland pastures and differs from makou, *R. hawaiiensis*, in having leaves only once compound, few small flowers, and smaller fruits with a pronounced hooked beak.

THREATS: Feral ungulates: goats, mouflon sheep, and cattle may impact this herbaceous species, although Degener and Degener (1960) commented that the species is acrid and unpalatable to animals. Rats are suspected seed predators. Alien grasses may displace plants and degrade habitat. Fire is a potential threat.

MANAGEMENT/RESTORATION STRATEGIES: Fencing and control of feral ungulates and mouflon sheep is currently underway in the Kahuku Unit. Additional rare plant surveys are planned for this area. Seed collection and propagation have been undertaken, but a planting of several seedlings inside a silversword enclosure in subalpine woodland of eastern Kahuku was not successful. Further restoration efforts for makou are planned at Kahuku Unit in ungulate-free areas without alien grass cover (McDaniel *et al.* 2008). The impacts of rats on this species and feasibility of control have not been studied.

REMARKS: Populations of makou or *R. hawaiiensis* seem to be in decline statewide. A small population **was found almost 30 years ago near the Kahuku boundary in the eastern part of Ka`ū Forest Reserve near the western edge of Kapāpala Forest Reserve** (L. Pratt, pers. obs.) and was recently relocated, but feral cattle threaten these plants (K. Bio, pers. comm.).

CULTURAL USES/ETHNOBOTANY: None known.



Kauila, *Alphitonia ponderosa*

Photos: Linda Pratt, USGS, PIERC, plant; Thomas Belfield, PCSU/NPS, HAVO, flowers and fruit

COMMON NAME: **Kauila**

SCIENTIFIC NAME: *Alphitonia ponderosa*

FAMILY: Rhamnaceae (Buckthorn Family)

SYNONYMS: *Alphitonia excelsa*, *A. ponderosa* var. *kauila*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: A small to large tree to 24 m height; bark light grey, rough in large trees. Leaves alternate, ovate in shape, thick in texture, dark green above, covered with rust-colored hairs on the underside. Flowers are borne in axillary cymes, 6–8 cm long, among young leaves; flowers are small, cream-colored, with five, rusty to white, hairy sepals, five petals, and five short stamens. Fruits are dry globose, black, almost indehiscent capsules, 14–18 mm in diameter with a ring around the middle. Seeds are 6 mm long, shiny brown with a reddish fleshy appendage (aril) (Wagner *et al.* 1999). Phenology: Flowers and fruits in any season (HAVO Herbarium).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: **Kaua`i, O`ahu, Moloka`i, Lāna`i, Maui, and Hawai`i**, usually on leeward slopes below 1,250 m (4,100 ft) elevation. On Hawai`i Island, the tree is distributed from North Kona to South Point and also occurs on Kīlauea.

HAVO DISTRIBUTION: Near Kīpuka Nēnē in unburned woodlands; kīpuka along Hilina Pali from the road's end to Pepeiau; and the western lowlands near the Great Crack. Formerly known from Nāulu Forest, Kealakomo kīpuka, Poliokeawe Pali, and Hilina Pali woodlands; planted and persisting at Kīpuka Puaulu and Kīpuka Kī. Formerly planted at Hilina Pali, `Āinahou Ranch, Kīpuka Nēnē (Morris 1967; N. Zimmer, unpublished data), and Nāulu (Belfield *et al.* 2011). Hilina and Nāulu plants are gone, a single tree persists at Kīpuka Nēnē, and the fate of the `Āinahou plantings is unknown. Known historically from Kahuku Unit at sites near the 1887 lava flow (Benitez *et al.* 2008), where a single kauila tree was discovered in 2011 (M. Wasser, pers. comm.).

HABITAT: Dry to mesic forest and woodland of the lowlands and middle-elevations.

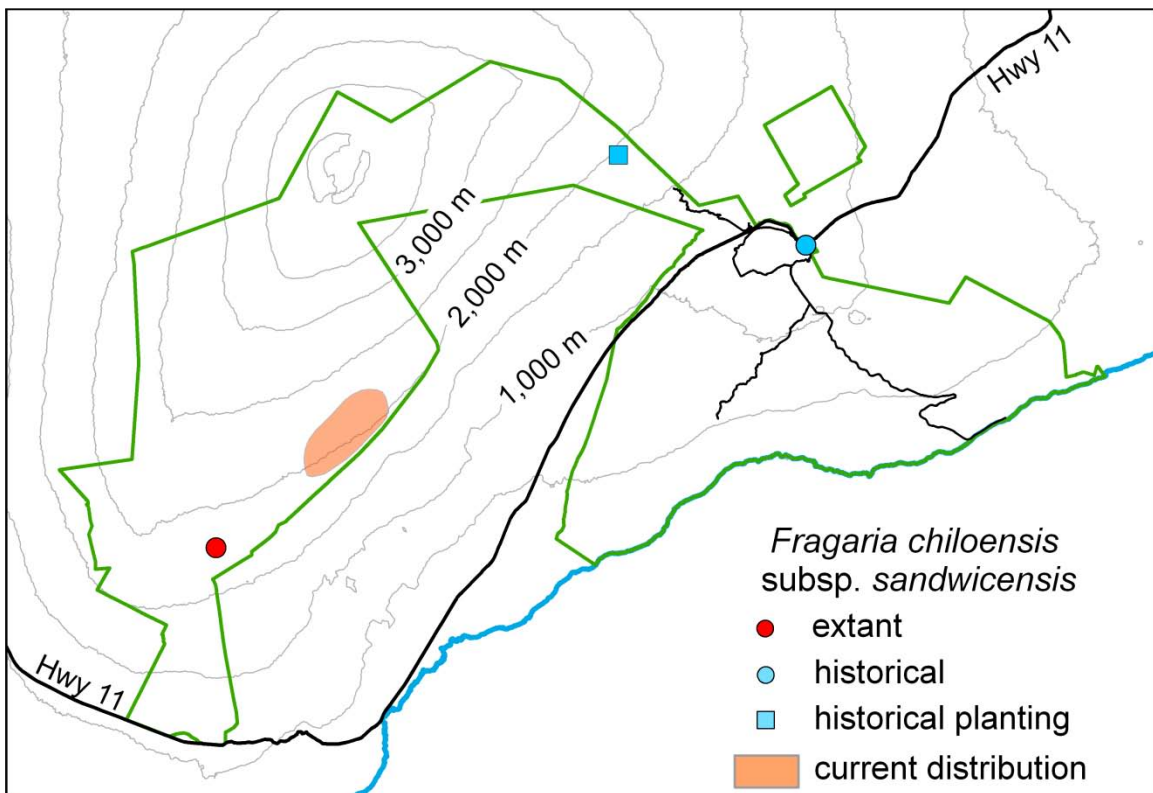
SIMILAR SPECIES: *Colubrina oppositifolia*, a related species with the same Hawaiian name, bears a close resemblance to *A. ponderosa*, but is not found within HAVO. The two species may be distinguished by their fruit; *Colubrina* fruit has a ring at its base, and *Alphitonia* fruit is ringed around the middle.

THREATS: Fire is the greatest threat to kauila in HAVO, where alien, fire-adapted molasses grass, bush beardgrass, and broomsedge have invaded dry woodlands, resulting in increased fire intensity and frequency (Smith and Tunison 1992). Feral goats were former threats. Culliney and Koebele (1999) reported that adult kauila are attacked by the black twig borer, but its impact on wild plants is unstudied. This alien insect is widespread in Hawai`i and has been documented from >100 host species (Hara and Beardsley 1979).

MANAGEMENT/RESTORATION STRATEGIES: Kauila is an uncommon natural component of HAVO dry forests. Park managers protect remaining dry forests from wildfire and goats and have treated alien grasses at Nāulu. **Early planting attempts of >60 trees (1941–1957)** largely failed within HAVO (Morris 1967). About 20 kauila were recently (2000–2005) planted at Nāulu Forest, but none survived 10 years (Belfield *et al.* 2011). **Trees planted decades ago in Kīpuka Puaulu and natural trees were used as seed sources** (N. Zimmer, unpublished data).

REMARKS: This tree was rare throughout its range 100 years ago (Rock 1913). Within HAVO, kauila no longer occurs naturally at Nāulu Forest or Kealakomo, where it was reported >50 years ago (Fagerlund and Mitchell 1944, Stone 1959). In the 1970s, kauila was scattered in woodlands between Kīpuka Nēnē and Hilina Pali (N. Zimmer, unpublished data). This area burned in 1987, and no kauila trees were found when the fire-altered woodland was searched in 1995.

CULTURAL USES/ETHNOBOTANY: The hard, red wood of kauila was used by Hawaiians for spears and kapa (bark cloth) beaters (Rock 1913) and for house construction (Degener 1975).



‘Ōhelo papa, Hawaiian strawberry, *Fragaria chiloensis* subsp. *sandwicensis*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **ʻŌhelo papa, Hawaiian strawberry**

SCIENTIFIC NAME: *Fragaria chiloensis* subsp. *sandwicensis*

FAMILY: Rosaceae (Rose Family)

SYNONYMS: *Fragaria chiloensis* var. *sandwicensis*, *F. vesca* var. *chiloensis*, *F. sandwicensis*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Terrestrial perennial herb; spreading by long stolons (sprawling stems). Leaves are palmately compound with three leaflets; leaflets are dark green and glossy above and densely hairy below, with coarsely toothed margins. Flowers are flat and open, borne on long silky-hairy stems, with five white petals, each 8–11 mm long, and numerous yellow stamens. Fruits are red, 1–1.5 cm long, aggregate fruits composed of a fleshy receptacle with tiny dry achenes embedded in pits on the surface (Wagner *et al.* 1999). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Maui and Hawai`i Islands, at relatively high elevation of 1,160–3,070 m (3,800–10,070 ft).

HAVO DISTRIBUTION: In the Kahuku Unit, this strawberry occurs in large numbers at scattered localities **within subalpine shrubland north of the Ka`ū Forest Reserve**. Not definitely known from the original park (Fosberg 1966), but **collected near Kīlauea Crater in the 1840s (Bishop Museum Herbarium) and documented in adjacent lands of Keauhou and Kapāpala Forest Reserve**. This species may have occurred in the Mauna Loa Strip, where it was recently planted.

HABITAT: Subalpine shrubland. The Hawaiian strawberry appears to persist most often in collapsed lava tubes, old flow channels, and shallow swales at Kahuku Unit; this restricted habitat may be a result of ungulate damage. Wagner *et al.* (1999) also list wet forest as habitat.

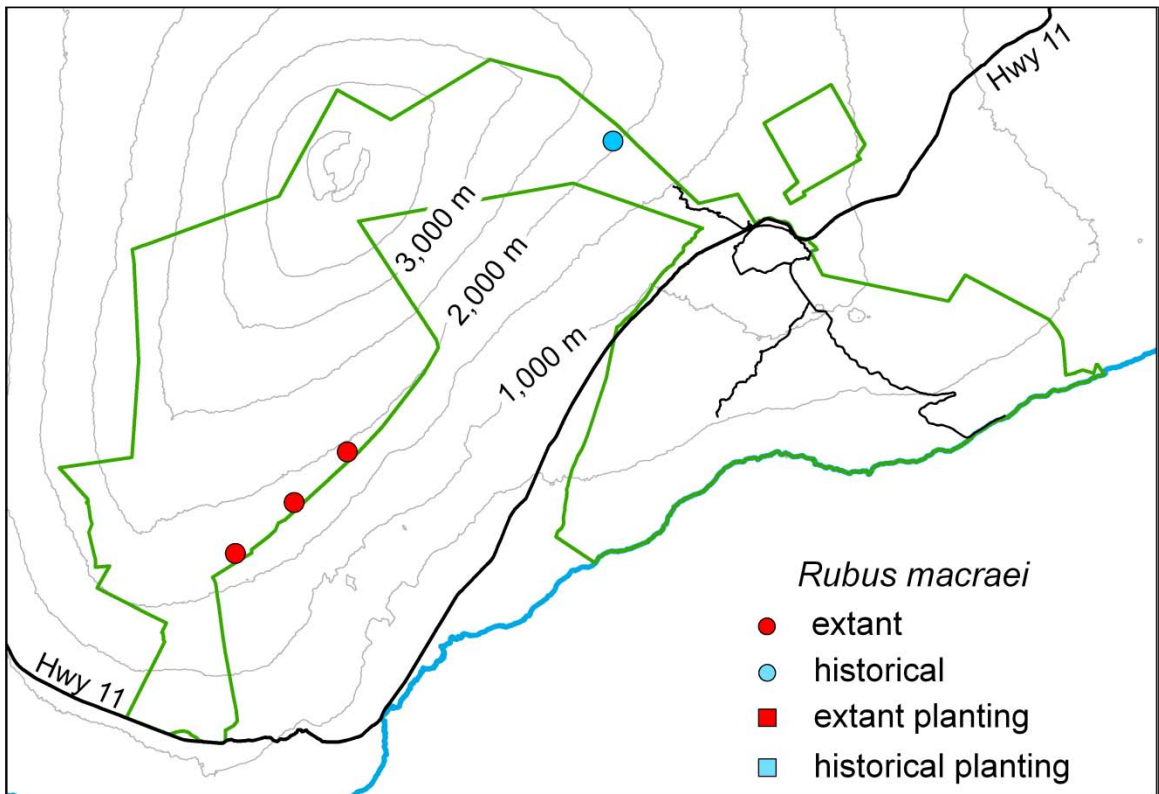
SIMILAR SPECIES: The European strawberry (*Fragaria vesca*), an introduced plant with white fruit, is very similar vegetatively to the native species. The two species may be easily distinguished when fertile, because *F. chiloensis* has large red fruit and large flowers borne below the foliage, while *F. vesca* bears small, white strawberries and small flowers on stems above the leaves. The leaves of *F. vesca* are thinner than those of the native species and are less densely hairy on the lower surfaces. The two species grow in the same habitat, but the introduced *F. vesca* is far more common on Hawai`i Island.

THREATS: Feral pigs and goats may browse on this herbaceous species or damage its habitat by digging and trampling. The presence of this native strawberry at Kahuku Unit indicates that mouflon sheep, which are well-established at Kahuku, may not be the primary threat. Alien slugs are a potential threat to the herbaceous Hawaiian strawberry. Wagner *et al.* (1999) speculated that a pathogen introduced with the European white strawberry may be responsible for the rarity of the native strawberry on Hawai`i. Maui lacks the introduced strawberry, and the native species is much more common there.

MANAGEMENT/RESTORATION STRATEGIES: Hawaiian strawberry will likely persist at Kahuku, particularly since there are ongoing efforts to reduce mouflon sheep and feral pigs. The strawberry was introduced to the ungulate-free upper Mauna Loa Strip of HAVO in the 2000s, but plantings did not survive 7–8 years (Belfield *et al.* 2011). The climate of the Mauna Loa Strip may be too dry for establishment of this strawberry.

REMARKS: The Hawaiian strawberry is an endemic subspecies of a species native to coastal North America, South America, and the Juan Fernandez Islands. The high-elevation habitat of the subspecies on Maui and Hawai`i is very different from the coastal habitat of the American species (Fosberg 1969). Because the Hawaiian strawberry is relatively abundant on the island of Maui, the plant is unlikely to be listed as endangered in the near future.

CULTURAL USES/ETHNOBOTANY: The fruits of the species and the endemic subspecies are edible.



`Ākala, Hawaiian raspberry, *Rubus macraei*
Photo: Thane Pratt, USGS, PIERC

COMMON NAME: **`Ākala, Macrae's raspberry**

SCIENTIFIC NAME: *Rubus macraei*

FAMILY: Rosaceae (Rose Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Species of Concern, former Candidate Threatened/Endangered

DESCRIPTION: Sprawling prostrate, viny shrub with peeling bark. Branches densely hairy and sparsely covered with soft prickles. Leaves palmately compound, with three ovate or suborbicular leaflets; the terminal leaflet larger than the others, 5–8.5 cm long and 3–6 cm wide; upper surface of leaflets sparsely hairy; lower surface densely covered with soft, velvety hairs; margins irregularly and coarsely toothed; petioles 1.5–3.5 cm long, hairy and prickly; linear stipules to 1.5 cm long at base of leaves. Flowers in loose terminal inflorescences, on hairy and prickly pedicels 8–55 mm long; sepals five, ovate, 10–16 mm long, hairy; petals five, rose-pink, obovate, 13–16 mm long; stamens are numerous in center of flower. Fruits are compound, composed of many fleshy drupelets fused together, red to dark purple, and 2.5–4 cm long, densely hairy. Each drupelet contains two seeds, flattened and roughly patterned (Wagner *et al.* 1999). Phenology: Unknown, but probably flowers in the spring like the Hawaiian raspberry.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: East Maui and Hawai`i, at relatively high elevations between 1,610 and 2,080 m (5,280–6,820 ft).

HAVO DISTRIBUTION: Kahuku Unit on the upper edge of forests north of Ka`ū Forest Reserve.

Reported from the upper Mauna Loa Strip by Fosberg (1966). All raspberry plants recently observed **along the Mauna Loa Road appear to be the more common `ākala, *Rubus hawaiiensis*.**

HABITAT: Montane wet forests, bog margins, and subalpine shrubland or grassland.

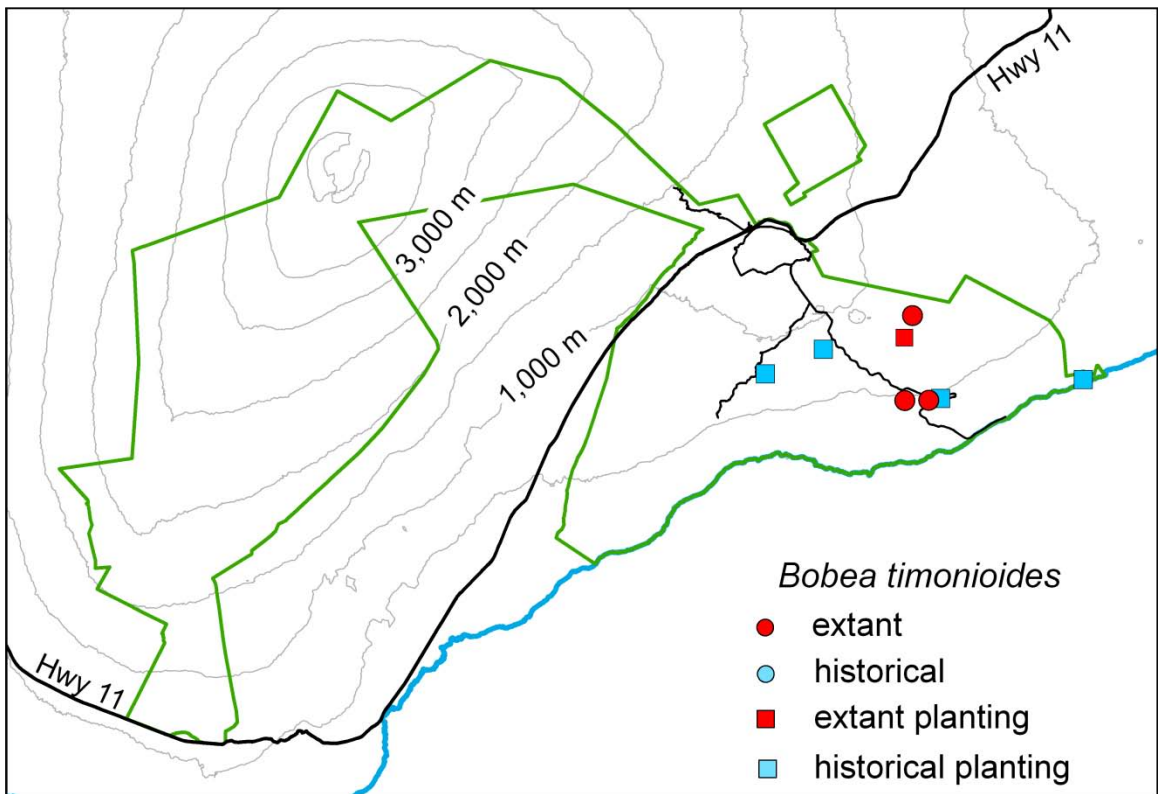
SIMILAR SPECIES: `Ākala or Hawaiian raspberry (*Rubus hawaiiensis*), a relatively common shrub, is erect and taller than *R. macraei*. Its leaves are thin, and leaflets are ovate to rhombic-ovate rather than nearly round. The terminal leaflet of *R. hawaiiensis* is larger (>8 cm long) than that of *R. macraei*.

THREATS: Feral goats, sheep, and pigs are threats to this soft, partly unarmed, low-growing, shrubby species. Grazing by cattle has probably reduced the cover of **`ākala in upland areas converted to pasture.**

MANAGEMENT/RESTORATION STRATEGIES: Most of the Mauna Loa Strip is protected within three fenced units of the Mauna Loa Special Ecological Area, where feral animals have been removed. This **rare `ākala will likely benefit from current efforts to reduce feral animals and mouflon sheep at Kahuku. This `ākala has not been used in planting projects in HAVO. The species could be considered for** augmentation in managed subalpine areas at Kahuku Unit, and it could probably be used for restoration projects in moist sites of the Mauna Loa Strip in the original section of HAVO.

REMARKS: The specimens cited as *Rubus macraei* by Fosberg (1966) that are stored in the HAVO Herbarium actually represent *R. hawaiiensis*. Because of this misidentification, it is uncertain whether the rare species actually occurred in the Mauna Loa Strip of HAVO. *Rubus macraei* is known from subalpine **forest edges at Keauhou Ranch and Kūlani Correctional Facility north and east of the park** (J. Jacobi and K. Bio, pers. comm.). Degener (1946) considered this species to be rare more than 60 years ago.

CULTURAL USES/ETHNOBOTANY: The fruits of native raspberries are edible and were probably used as food by Hawaiians (Hillebrand 1888). A pink dye for kapa (bark cloth) may be obtained from the juice of the fruits (Abbott 1992).



^ Ahakea, *Bobea timonioides*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **`Ahakea**

SCIENTIFIC NAME: *Bobea timonioides*

FAMILY: Rubiaceae (Coffee Family)

SYNONYMS: *Obbea timonioides*

FEDERAL AND STATE STATUS: Species of Concern, former Candidate

DESCRIPTION: Small to medium-size tree with light-colored, smooth bark. Leaves opposite, ovate to elliptic, 4–10 cm long and 2–6.5 cm wide, with prominent red secondary veins. Leaf undersides sparsely hairy on veins and midribs; round, shallow pits found in axils of secondary veins. Petioles with triangular stipules between leaves. Flowers perfect or unisexual, perfect and male borne in small inflorescences of three to seven greenish-white tubular flowers about 1 cm long, female flowers solitary with corolla tube 5–10 mm long. Fruit ovoid, sparsely hairy, 7–10 mm long, with 4–7 thick-walled one-seeded sections, purplish-black when ripe (Wagner *et al.* 1999). Phenology: Flowers in all seasons except summer; fruits throughout the year (Pratt *et al.* 2011).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: East Maui and Hawai`i Island at 250–580 m (820–1,900 ft) elevation. There are a few collections of this species from O`ahu and Kaua`i. On Hawai`i Island it is limited to Puna and South Kona Districts according to Wagner *et al.* (1999), although Hillebrand (1888) also listed Kawaihae Uka on leeward Kohala.

HAVO DISTRIBUTION: Nāulu Forest and Kealakomo kīpuka, where 46 `ahakea were mapped in 1994 (Abbott and Pratt 1996). Trees that may be this species were observed in East Rift rain forests. Recently **planted at Nāulu** (unsuccessfully) and in the East Rift Special Ecological Area south of Makaopuhi Crater. **Earlier plantings at Waha`ula, `Āinahou, and Kīpuka NĒNĒ failed.**

HABITAT: Lowland dry to mesic luma forest.

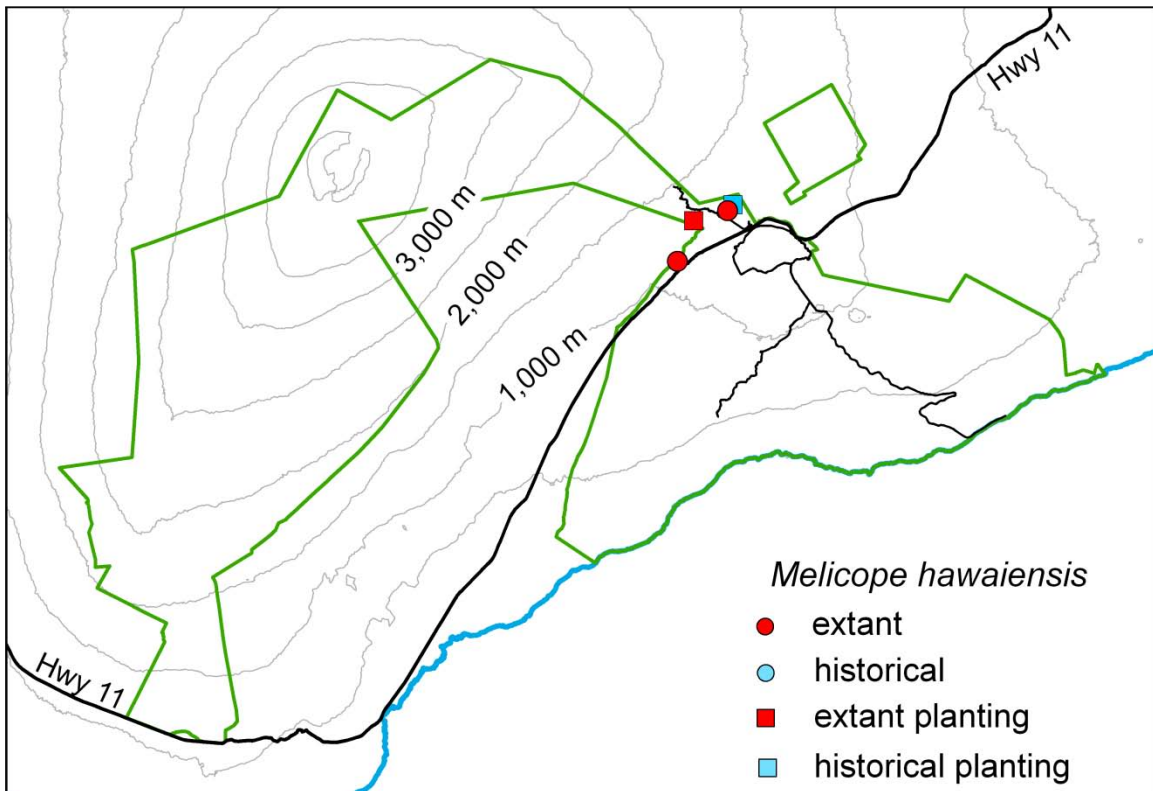
SIMILAR SPECIES: Several native trees in the Coffee Family share `ahakea's dry and mesic forest habitat. Similar species that have opposite leaves are alahe`e (*Psydrax odorata*), **kōpiko `ula** (*Psychotria hawaiiensis* var. *hillebrandii*), and pilo (*Coprosma menziesii*). Alahe`e has very shiny leaves without **prominent secondary veins, and its fragrant, white flowers are borne in large clusters.** **Kōpiko `ula** has shiny, prominently-veined leaves, but its white, tubular flowers are borne in loose clusters and its orange, fleshy fruit are unmistakable. It is unlikely that pilo would be confused with `ahakea, as it is a sprawling plant of low stature, has small leaves, and bears showy, orange, fleshy fruits with two large seeds.

THREATS: Feral goats formerly damaged the bark of adult trees in HAVO; most large `ahakea trunks bear scars. Fire is a threat to dry forest species in areas invaded by alien fire-adapted grasses. Alien lantana shrubs and Asian swordfern **persist in the ground cover in Nāulu Forest and Kealakomo, and may compete for limited seedling-establishment sites.** **The current forests with `ahakea are in small kīpuka** subject to drying winds and frequent sulfur dioxide-laden vog that burns leaves. Much of the known HAVO population has died in the last 13 years, and young plants are not observed.

MANAGEMENT/RESTORATION STRATEGIES: The habitat of `ahakea is free of feral goats, fires are suppressed, and several invasive plant species have been partially controlled. `Ahakea was planted in **Nāulu Forest in 2001–2005**; but none survived five to nine years (Belfield *et al.* 2011). Young plants were recently placed in an alternative planting site in East Rift SEA forest (Loh 2008a). The species may also be suitable for introduction to Kahuku, as it grows in the **adjacent Manukā Natural Area Reserve** (Hawai`i Department of Land and Natural Resources 1992).

REMARKS: Recent collections have confirmed the species on Kaua`i (Lorence *et al.* 1995).

CULTURAL USES/ETHNOBOTANY: The yellow wood of some species of `ahakea (*B. elatior*) was used by Hawaiians for the top rim of outrigger canoes and for poi boards (Rock 1913).



Manena, Mokihana kūkae moa, *Melicope hawaiiensis*

Photo: Thane Pratt, USGS, PIERC, tree; Thomas Belfield, PCSU/NPS, HAVO, fruit capsules

COMMON NAME: **Manena, Mokihana kūkae moa**

SCIENTIFIC NAME: *Melicope hawaiiensis*

FAMILY: Rutaceae (Rue Family)

SYNONYMS: *Pelea brighamii*; *P. cinerea* var. *hawaiiensis*, *P. c.* var. *racemiflora*, *P. c.* var. *rubra*, *P. c.* var. *sulfurea*; *P. gaudichaudii*; *P. hawaiiensis*, *P. h.* var. *brighamii*, *P. h.* var. *gaudichaudii*, *P. h.* var. *molokaiana*, *P. h.* var. *pilosa*, *P. h.* var. *racemiflora*, *P. h.* var. *remyana*, *P. h.* var. *rubra*, *P. h.* var. *sulfurea*; *P. kilauaeaensis*; *P. sulfurea*

FEDERAL AND STATE STATUS: Species of Concern, formerly a Candidate

DESCRIPTION: Tree to 10 m in height (to 16 m tall in HAVO); bark smooth and pale brown to white. Leaves opposite, thick in texture, elliptic to oblong-elliptic, 5–20 cm long and 3–8 cm wide, upper surface hairless except for midrib, lower surface sparsely hairy; leaf tip rounded, leaf base cuneate, truncate, or cordate. Flowers small, 3 to 30, clustered in densely hairy axillary inflorescences with stalks to 30 mm; sepals ovate, ca. 3 mm long, densely hairy; petals four, green to white, reddish inside, ca. 4 mm long, hairy; stamens eight. Fruits are four-parted capsules, 16–34 mm wide, with separate fruit sections, covered with golden-brown or reddish-brown hairs. Seeds one to two per follicle, 4–7 mm long, shiny black (Wagner *et al.* 1999). Phenology: Flowers in winter/spring and fruits observed in summer and fall (Pratt *et al.* 2010).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Moloka`i, Lāna`i, Maui, and Hawai`i between 610 and 1,220 m (2,000–4,000 ft) elevation. Rare on Hawai`i Island.

HAVO DISTRIBUTION: Kīpuka Puaulu, where 150 trees were mapped in the mid 1990s (Pratt *et al.* 2010); also recently planted in Kīpuka Kī. There is also a small disjunct population on the boundary with Kapāpala Ranch near 1,070 m (3,500 ft) elevation.

HABITAT: Montane mesic forest of koa, `ōhi`a lehua, and manele and montane dry `ōhi`a forest in HAVO; on other islands, manena is found in dry forests.

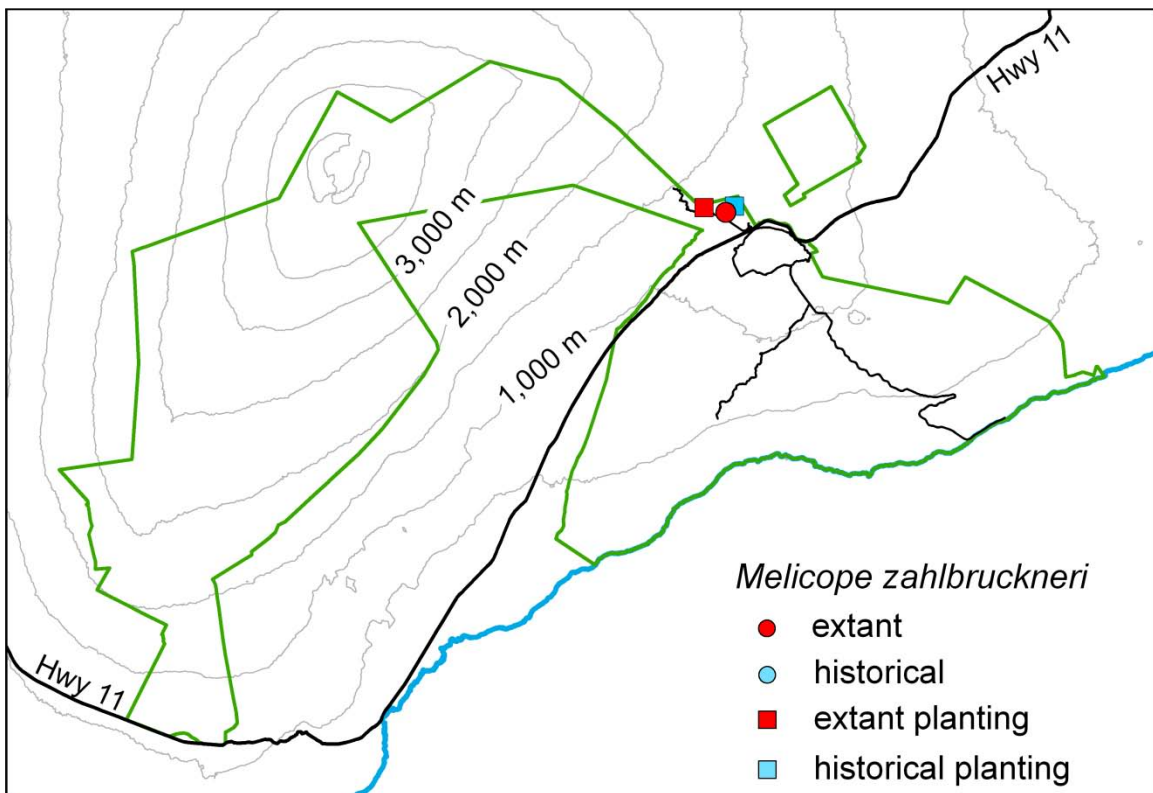
SIMILAR SPECIES: Several other species of *Melicope* share the same mesic forest habitat in HAVO: *M. zahlbruckneri*, an endangered species, and the more common *M. radiata* and *M. pseudoanisata*. *M. hawaiiensis* differs from the other species in its fruit capsules, which are small, hairy, and have separate sections. The leaves of *M. hawaiiensis* are distinctively narrow, and its bark is very light-colored, almost white. In Kīpuka Puaulu, *M. hawaiiensis* attains a much greater stature than the other three *Melicope* spp., which are small- to medium-sized trees.

THREATS: Fire is a threat to this dry and mesic forest tree. Feral goats and sheep, mouflon sheep, and cattle have severely impacted its habitat outside the park. There are problems with reproduction, as few intact seeds are observed on many park trees, and seedlings are seldom seen. Larvae of a native moth (*Prays* sp.) and alien rats are implicated as seed predators of *Melicope* species (Zimmerman 1978, Pratt *et al.* 2010).

MANAGEMENT/RESTORATION STRATEGIES: The habitat of this tree at HAVO is protected from fire, feral animals, and invasive alien plants. A few manena were planted in Kīpuka Puaulu in the 1970s (N. Zimmer, unpublished data) and in Kīpuka Kī in the 2000s (Belfield *et al.* 2011). A larger planting at Kīpuka Kī was planned, but manena was difficult to germinate and only three were planted. Seed studies are warranted. Large-scale rat control has not been tested.

REMARKS: At least 10 former varieties and species have been subsumed under *Melicope hawaiiensis*. There are early collections from Hu`ehu`e and Pu`uwa`awa`a in Kona, Kawaihae Uka in Kohala, and a site in Ka`ū Desert, presumably within HAVO (Stone 1969). The tree has also been observed at Manukā (Hawai`i Department of Land and Natural Resources 1992), Pōhakuloa Training Area (Shaw 1997) and Keauhou Ranch (L. Pratt, pers. obs.).

CULTURAL USES/ETHNOBOTANY: None known.



Alani, Zahlbruckner's alani, *Melicope zahlbruckneri*

Photos: Linda Pratt, USGS, PIERC, branch; Keali'i Bio, Hawai'i Plant Extinction Prevention Program, fruit capsule

COMMON NAME: **Alani, Zahlbruckner's alani**

SCIENTIFIC NAME: *Melicope zahlbruckneri*

FAMILY: Rutaceae (Rue Family)

SYNONYMS: *Pelea zahlbruckneri*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1996

DESCRIPTION: Small to medium-size tree, 10–12 m tall. Leaves opposite, thick in texture, oblong-elliptic to almost round, 6–24 cm long and 4–13 cm wide, upper surface hairless and lower surface with short hairs, leaf margins usually rolled inward, particularly at base of leaf. Flowers unisexual, two to five in axillary inflorescences on stalks 15–20 mm long; female flowers have hairless triangular sepals 1.5 mm long and green to white petals 3 mm long, non-fertile stamens, and a short (1 mm) style; male flowers have triangular to ovate sepals 3.5 mm long, triangular, hairless petals 6 mm long, eight stamens in two whorls, exerted beyond the corolla, and a non-functional style. Fruits are cuboid, four-parted capsules, with sections fused more than 2/3 their length, up to 30 mm wide, hairless inside and outside, green when young and brown when mature. Seeds one to two per section (follicle), shiny black, 7–8 mm long (Wagner *et al.* 1999). Phenology: Buds and flowers all year; few fruits seen (Pratt *et al.* 2010).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island; known from few sites including **Kīpuka Puaulu and Moa`ula in Ka`ū District** and Glenwood in Puna District (Wagner *et al.* 1999). It was **recently reported from Laupāhoehoe Natural Area Reserve in Hamākua District.**

HAVO DISTRIBUTION: Kīpuka Puaulu is the only known park site naturally supporting this tree. A 1993 survey and mapping project in the kīpuka documented 34 individual trees of **Zahlbruckner's alani**; recently only 20 trees could be located (Pratt *et al.* 2010). **A few trees have been planted at Kīpuka Kī.**

HABITAT: Montane mesic forest. At Kīpuka Puaulu, the tree grows in montane mesic forest of koa, `ōhi`a lehua, and mānele.

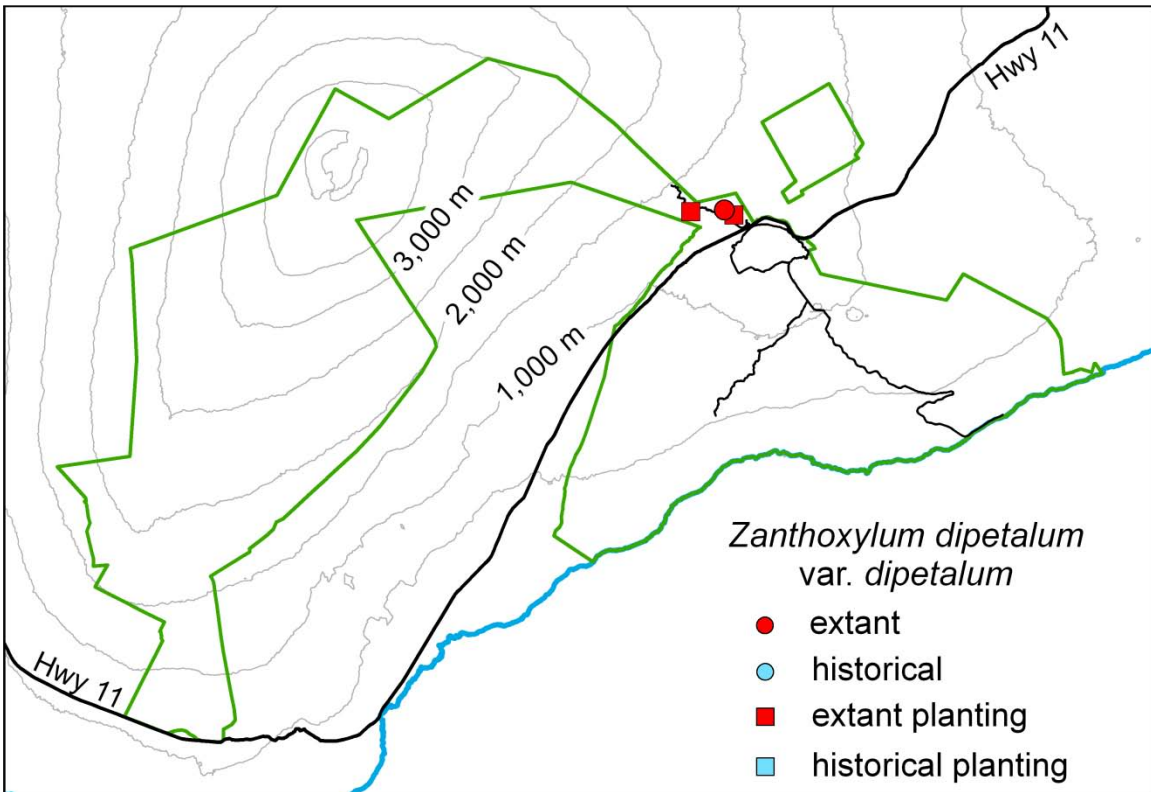
SIMILAR SPECIES: Several other species of *Melicope* share the same mesic forest habitat in HAVO: *M. hawaiiensis*, a SOC; *M. radiata*; and *M. pseudoanisata*. *Melicope zahlbruckneri* may be distinguished from these species by its large leaves with in-rolled margins and by its unusual cuboid capsular fruits.

THREATS: In the past, feral ungulates and cattle threatened this species. Larvae of a native moth (*Prays* sp.) (Zimmerman 1978) limit seed production and reproduction. Capsules are rarely seen on most trees, and seeds are difficult to germinate in the greenhouse (Pratt *et al.* 2010). Rats are suspected as seed predators of fallen seeds. Natural pollinators may have been lost. Low population size may have contributed to loss of reproductive vigor.

MANAGEMENT/RESTORATION STRATEGIES: Kīpuka Puaulu is protected from feral ungulates, and invasive alien plants are controlled. A project recently investigated phenology and limiting factors of the species (Pratt *et al.* 2010). Research may be needed to determine effective propagation techniques for **Zahlbruckner's alani and to investigate the seed-predating native insect.** Four alani trees were recently **planted at Kīpuka Kī and have persisted** more than four years (Belfield *et al.* 2011). Past plantings at **Kīpuka Puaulu failed** (N. Zimmer, unpublished data). The feasibility of large-scale rat control to protect rare plants has not been studied.

REMARKS: This species is one of the rarest and distributionally restricted members of the genus *Melicope* in the Hawaiian Islands. The park population is apparently the largest and most structurally diverse of the two **extant stands of this species; the protection of Kīpuka Puaulu is critical to its survival.** In 1911, Joseph Rock described the **species as "quite plentiful" in the kīpuka (Rock 1913, p. 233); clearly** the population has declined in the last century.

CULTURAL USES/ETHNOBOTANY: None known.



Kāwa`u, *Zanthoxylum dipetalum* var. *dipetalum*
Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Kāwa`u**

SCIENTIFIC NAME: *Zanthoxylum dipetalum* var. *dipetalum*

FAMILY: Rutaceae (Rue Family)

SYNONYMS: *Fagara dipetala*, *F. d.* var. *degeneri*, *F. d.* var. *geminicarpa*, *F. d.* var. *hillebrandii*, *F. d.* var. *mannii*; *Zanthoxylum dipetalum* var. *degeneri*, *Z. d.* var. *geminicarpum*, *Z. d.* var. *hillebrandii*, *Z. d.* var. *mannii*

FEDERAL AND STATE STATUS: Species of Concern, formerly a Candidate

DESCRIPTION: Tree, dioecious, to 15 m tall, with finely fissured bark. Leaves pinnately compound with 3–7 leaflets; lowest pair much smaller than others and folded over; normal leaflets oblong-elliptic to broadly elliptic, 6–15 cm long and 3.5–9 cm wide, leaflet surfaces smooth, lower surface may be hairy, conspicuously dotted with glands, margins entire, apex rounded, base rounded or cuneate; leaflet petioles 3–9 mm long, longer in terminal leaflet. Flowers unisexual, 5–15 in terminal, open inflorescences 5–10 cm long, inflorescence stalk 10–40 mm long. Individual flowers small, with four ovate sepals 1–1.5 mm long, 2–4 yellowish-white, red-tinged petals, lanceolate to ovate, 6–10 mm long; male flowers with four stamens and a rudimentary ovary; female flowers lacking stamens, with a two-sectioned ovary, short style, and round stigma. Fruits are dry, dehiscent follicles (pods), ovoid, 15–25 mm long, glandular-pitted on surface, with a beaked apex 3–8 mm long; two follicles usually develop from a flower. Seeds shiny black, 10–26 mm long, one per follicle (Wagner *et al.* 1999). Phenology: Flowers and fruits all year.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Kaua`i, O`ahu, Moloka`i, and Hawai`i; at elevations of 260–1,280 m (850–4,200 ft) (Wagner *et al.* 1999); now very rare except on Kaua`i. On Hawai`i the species has been recorded only from Kawaihae Uka, leeward Kohala, and windward Mauna Loa (Hillebrand 1888). Recently reported from Manukā (K. Bio, pers. comm.).

HAVO DISTRIBUTION: Kīpuka Puaulu; also planted in Kīpuka Puaulu and Kīpuka Kī.

HABITAT: Montane mesic forest; diverse mesic forest of koa, `ōhi`a lehua, and mānele.

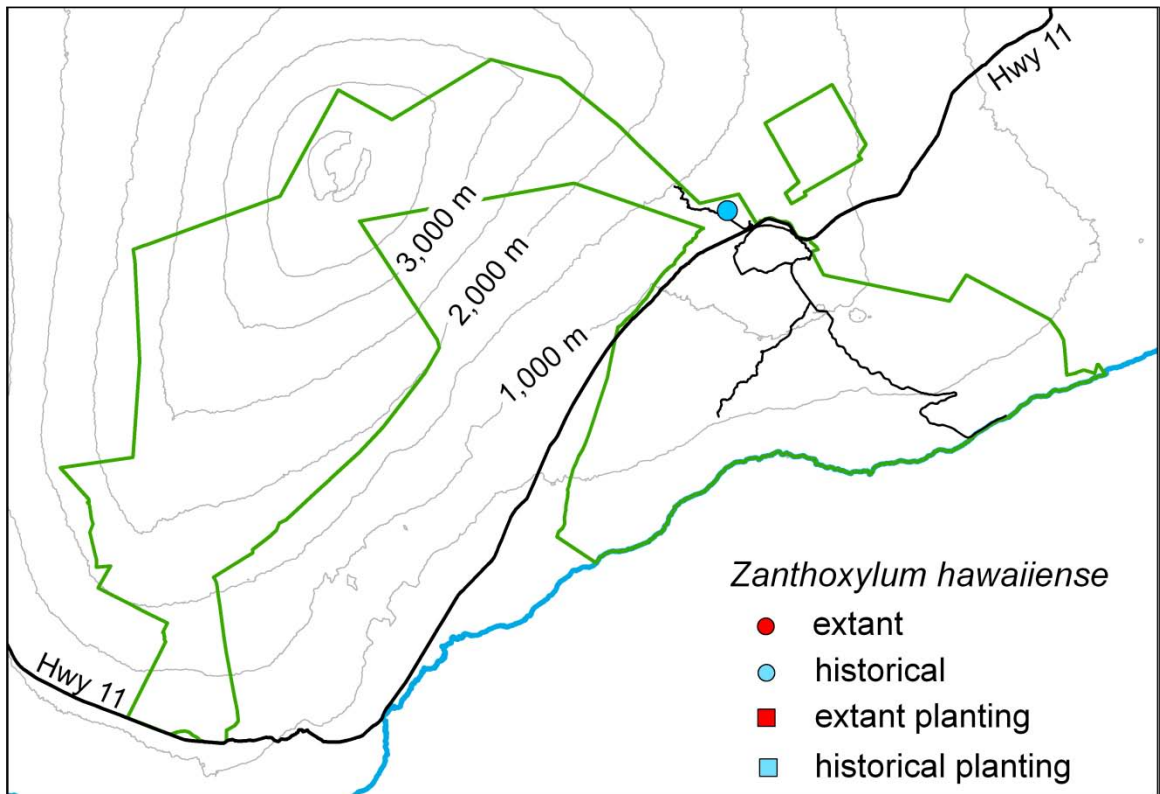
SIMILAR SPECIES: A`e or *Zanthoxylum kauaense* is also native to Kīpuka Puaulu and may be distinguished from *Z. dipetalum* by its leaves, which have three to seven leaflets but lack the reduced basal leaflets, and by its fruits, which are a single rather than two-parted pod without a long beak.

THREATS: Kalij pheasants have been identified as predators of small natural seedlings in Kīpuka Puaulu. Natural insect pollinators are unknown, but fruit production is high (Pratt *et al.* 2010). Alien grasses may interfere with seedling recruitment. Avian seed dispersers have likely been lost. Feral ungulates and cattle were former threats to kāwa`u.

MANAGEMENT/RESTORATION STRATEGIES: Kīpuka Puaulu is protected from cattle, feral goats, pigs, and most invasive alien plants. Kāwa`u was propagated in the 1970s, when 50 trees were planted in Kīpuka Puaulu (N. Zimmer, unpublished data). A few individuals (>11) were planted earlier at the kīpuka (Morris 1967). Three adult trees persist near the road in Kīpuka Kī; there is no record of the date of planting. In 2003, >80 large seedlings were planted at Kīpuka Kī; 40% survived for four years. A few kāwa`u were planted in Kīpuka Puaulu with 25% survival (Belfield *et al.* 2011). Plantings are planned for additional kīpuka (S. McDaniel, pers. comm.). Strategies to prevent predation by kalij pheasants have not been developed.

REMARKS: Rock (1913) reported that few kāwa`u trees grew in Kīpuka Puaulu. By the 1990s, >60 trees, including four very large ones, were mapped in the kīpuka, and >50 persisted in 2008 (Pratt *et al.* 2010); young trees probably represented both natural regeneration and planted individuals. Recent monitoring indicated that half of all fertile trees are male and half are female.

CULTURAL USES/ETHNOBOTANY: Hawaiians beat bark cloth upon the trunks (Wagner *et al.* 1999). Extracts of the leaves and fruit of this species have mild insecticidal properties (Marr and Tang 1992).



A`e, Hawai`i a`e, *Zanthoxylum hawaiiense*
Photo: Jonathan Price, © Smithsonian Institution, Botany Department

COMMON NAME: **A`e, Hawai`i a`e**

SCIENTIFIC NAME: *Zanthoxylum hawaiiense*

FAMILY: Rutaceae (Rue Family)

SYNONYMS: *Fagara bluetiana*; *F. hawaiiensis*, *F. h. var. citriodora*, *F. h. var. subacuta*, *F. h. var. velutinosa*; *Zanthoxylum bluetianum*; *Z. hawaiiense var. citriodora*, *Z. h. var. subacutum*, *Z. h. var. velutinosum*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Small tree to 8 m tall, bark pale and smooth. Leaves compound with three leaflets, lemon-scented; leaflets thick, broadly deltate-ovate, 3.5–10 cm long and 1.5–5 cm wide, hairless, lower surface sometimes with short hairs, dotted with glands, apex sharp-pointed, base asymmetrical, truncate to cuneate, margins with very small teeth. Flowers 15 to 20 in open, axillary inflorescences 4–8 cm long, with inflorescence stalk 2–5 cm long; individual male flowers with four sparsely hairy, deltate sepals 1 mm long, four petals 3–6 mm long, and four short stamens; female flowers lack stamens and have an ovary with one section (carpel) and a short style. Fruits are dry pods, splitting open on one side, obovoid, 8–10 mm long, with a rounded apex and rough, pitted surface. Seeds are black and shiny, 7–8 mm in diameter, one per fruit (Wagner *et al.* 1999). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Lāna`i, Moloka`i, Maui, and Hawai`i, at elevations of 550 to 1,740 m (1,800–5,710 ft). Also recently confirmed on Kaua`i. On Hawai`i Island, Hawai`i a`e occurs at Pōhakuloa Training Area (PTA) and Pu`uwa`awa`a.

HAVO DISTRIBUTION: Reported from Kīpuka Puauulu by Judd (1921). This observation is not documented by a specimen, and there are no reported occurrences of this species between Pōhakuloa and HAVO. No trees of this species persist at Kīpuka Puauulu today.

HABITAT: Montane dry forest on lava flows; sometimes in mesic forest. In HAVO, the species was reported in diverse montane mesic forest of koa, `ōhi`a lehua, and mānele.

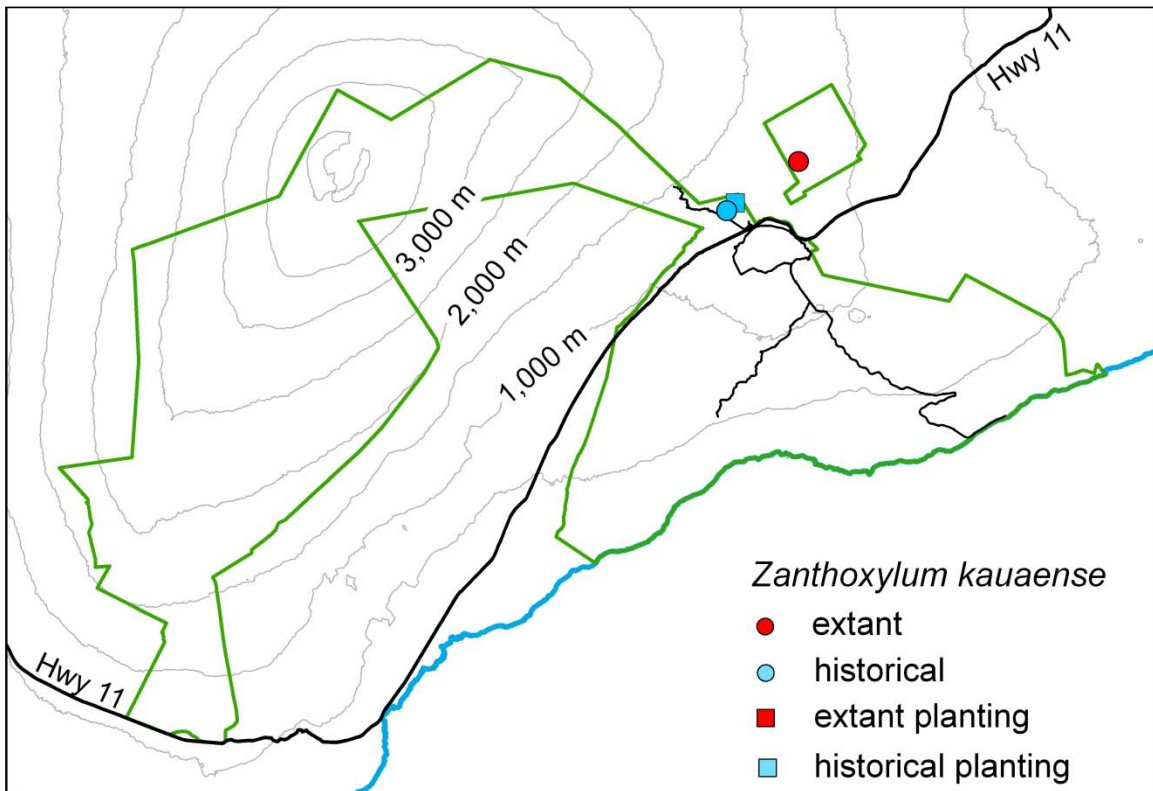
SIMILAR SPECIES: Kāwa`u, *Zanthoxylum dipetalum*, plants are numerous at Kīpuka Puauulu, but that species differs from Hawai`i a`e, *Z. hawaiiense*, in its very small, reduced lower leaflets and large, two-parted fruits.

THREATS: Elsewhere feral goats, sheep, and pigs, as well as domestic cattle, are threats to the species (U.S. Fish and Wildlife Service 1996). Alien plants and fire may be threats.

MANAGEMENT/RESTORATION STRATEGIES: All of the known threat elements have been present at **Kīpuka Puauulu in the past, but are now controlled there. Before management strategies are devised for this species at HAVO, it would be desirable to confirm the tree as a natural part of the flora of Kīpuka Puauulu and the park.** Specimens of Hawai`i a`e at Bishop Museum (or other herbaria) could be examined to determine if any label localities indicate HAVO.

REMARKS: It is difficult to determine whether this species actually belongs in HAVO. C. S. Judd is a very reliable source, as he was the Chief Territorial Forester for many years. However, his reference to a`e or *Zanthoxylum hawaiiense* may have been based on a misidentification or an erroneous report, and no specimens have been found to support the claim. Rock (1913), who surveyed the area in the early **1900s, did not mention the species as present at Kīpuka Puauulu.**

CULTURAL USES/ETHNOBOTANY: None known.



A`e, Kaua`e, *Zanthoxylum kauaense*

Photo: Thomas Belfield, PCSU/NPS, HAVO, in greenhouse

COMMON NAME: **A`e, Kaua a`e**

SCIENTIFIC NAME: *Zanthoxylum kauaense*

FAMILY: Rutaceae (Rue Family)

SYNONYMS: *Fagara kauaense*, *F. maviensis*; *Zanthoxylum hillebrandii*, *Z. maviensis*, *Z. molokaiense*, *Z. semiarticulatum*, *Z. skottsbergii*

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Small to medium-size tree to 15 m tall, bark brown to gray brown with prominent lines of pale lenticels. Tree dioecious with male and female flowers on different trees. Leaves compound with three to seven thick leaflets, ovate to elliptic or suborbicular, 4–19 cm long and 2–10 cm wide, hairless or covered with fine hairs, with conspicuous reticulate venation, dotted with glands, apex obtuse or rounded, base asymmetrical, cuneate to rounded, margins entire or with minute teeth. Flowers 15 to 150 in open, axillary inflorescences 8–15 cm long, with inflorescence stalk 1–7 cm long; individual male flowers with four to five, finely hairy, deltate sepals 1 mm long, 4–5 white petals, 4–5 mm long, and four to five short stamens; female flowers lack stamens and have an ovary with one section (carpel) and a short style ending in a head-like stigma. Fruit is a pod splitting on one side, obovoid, 8–12 mm long with a rough and pitted exterior. Seed is one per fruit, black, round and compressed, 7–13 mm in diameter (Wagner *et al.* 1999). Phenology: Unknown. HAVO Herbarium specimens had flowers in spring and fall.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: All main Hawaiian Islands except Ni`ihau and Kaho`olawe, between 300 and 1,980 m (985–6,490 ft) elevation.

HAVO DISTRIBUTION: Kīpuka Puaulu (tree now dead) and `Ōla`a Forest, Koa Unit (single tree known). The nearest population to HAVO is that of the `Ōla`a Forest Reserve.

HABITAT: Montane mesic forest, sometimes in wet or dry forest. In HAVO found in mesic koa/`ōhi`a lehua/mānele forest and montane wet `ōhi`a lehua/hāpu`u forest.

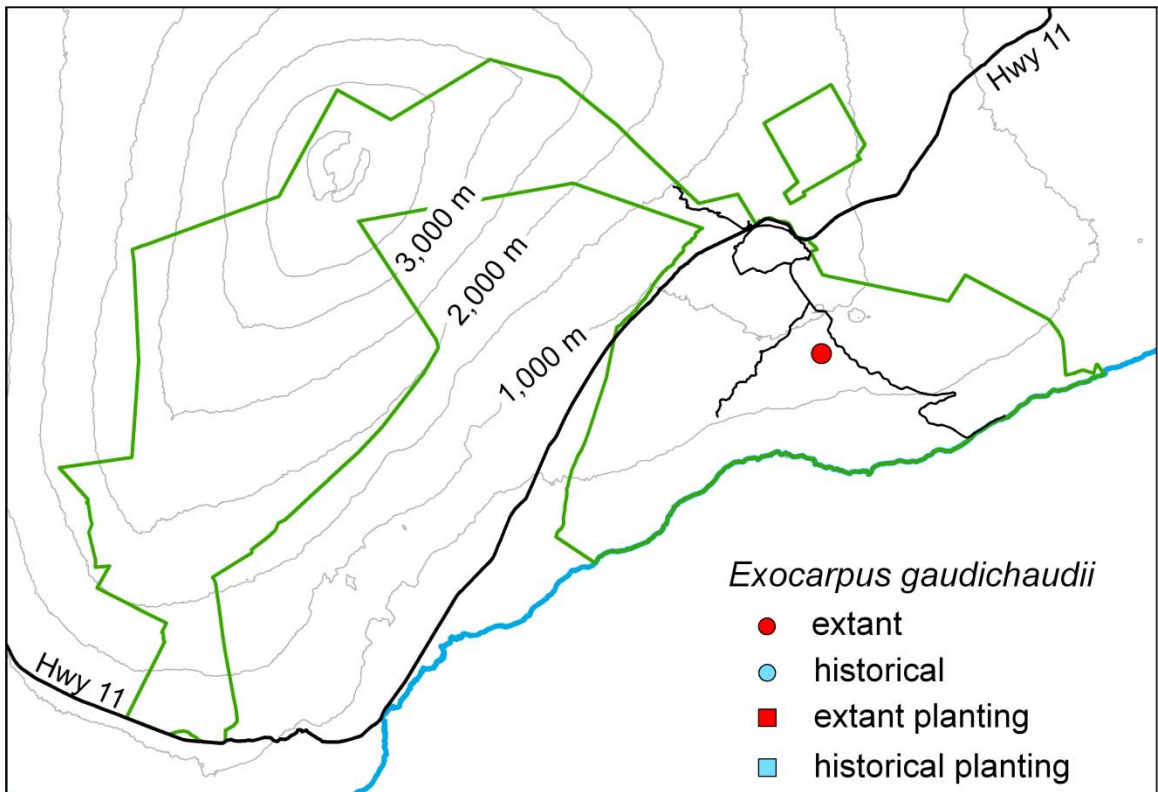
SIMILAR SPECIES: Kāwa`u or *Zanthoxylum dipetalum* has a similar appearance, but it has leaflets much thicker in texture, and the lowest pair of leaflets is greatly reduced in size. Also, the fruit of *Z. dipetalum* is much larger, has two sections (and seeds), and bears short horn-like structures. The flowers of *Z. dipetalum* have only two fleshy petals, which do not spread open.

THREATS: Reasons for decline of the species are unknown, but low numbers of individuals and the single-sex nature of the species may make reproduction less likely. Feral ungulates and domestic cattle likely impacted the park's a`e in the past. The high mortality of recent plantings was attributed to kalij pheasants, which browsed leaves and growing tips of small seedlings. Alien grass also appeared to contribute to loss of planted seedlings (T. Belfield, pers. comm.).

MANAGEMENT/RESTORATION STRATEGIES: The tree was observed and collected at Kīpuka Puaulu in the 1940s (Fagerlund and Mitchell 1944), but it was not found in subsequent surveys of the kīpuka in the 1960s (Mueller-Dombois and Lamoureux 1967). A single male tree was located within the kīpuka in 2001, but it subsequently died (T. Belfield, pers. comm.). Seedlings were propagated in the HAVO nursery from material collected in the nearby `Ōla`a Forest Reserve, and 10 were planted in Kīpuka Puaulu in 2003. Although early survivors were protected from kalij pheasants by exclosures, all plantings failed after 6–7 years (Belfield *et al.* 2011). Both Kīpuka Puaulu and `Ōla`a Koa Unit are free of feral ungulates. Surveys to search for more individuals in `Ōla`a Forest may be warranted, and additional plantings will be required if the species is to be restored to Kīpuka Puaulu.

REMARKS: Within its large range on multiple islands this species is recognized as quite variable in leaf shape and size and leaflet number. At least six formerly recognized species and many varieties have been subsumed under the currently recognized species (Wagner *et al.* 1999).

CULTURAL USES/ETHNOBOTANY: None known.



Hululmoa, Heau, *Exocarpus gaudichaudii*

Photos: Linda Pratt, USGS, PIERC, plant; Thomas Belfield, PCSU/NPS, HAVO, fruit

COMMON NAME: **Hulumoa, Heau**

SCIENTIFIC NAME: *Exocarpos gaudichaudii*

FAMILY: Santalaceae (Sandalwood Family)

SYNONYMS: *Exocarpos brachystachys*, *E. casuarinae*, *E. sandwicensis*

FEDERAL AND STATE STATUS: Species of Concern, formerly a Candidate

DESCRIPTION: Partially parasitic small tree or shrub, stems green, densely branched toward stem tips. Leaves reduced to scales, sometimes there are a few sessile, narrowly elliptic to obovate leaves, 38–60 mm long and 16–30 mm wide. Flowers borne in terminal or axillary spikes; individual flowers small, green to yellowish-green, with four to five green petals 1–3 mm long and five short stamens. Fruits are unusual green drupes 8–10 mm long, embedded in a red, fleshy receptacle, the exposed part 5–7 mm long (Wagner *et al.* 1999). Phenology: Unknown. Specimens in the HAVO Herbarium collected in spring and summer were sterile.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: All the main Hawaiian Islands except Kaua`i, at elevations between 250 and 1,550 m (820–5,080 ft). Often on ridges on the older islands. This species is rare on leeward Hawai`i Island.

HAVO DISTRIBUTION: `Āinahou, at a site near 850 m (2,800 ft) elevation, south of the ranch house.

HABITAT: Lowland to montane mesic forest and shrubland, rarely in open areas of wet forest. In HAVO **this species grows in open `ōhi`a lehua woodland with common native shrubs and other rare trees, such as Lāna`i kōlea and hō`awa.**

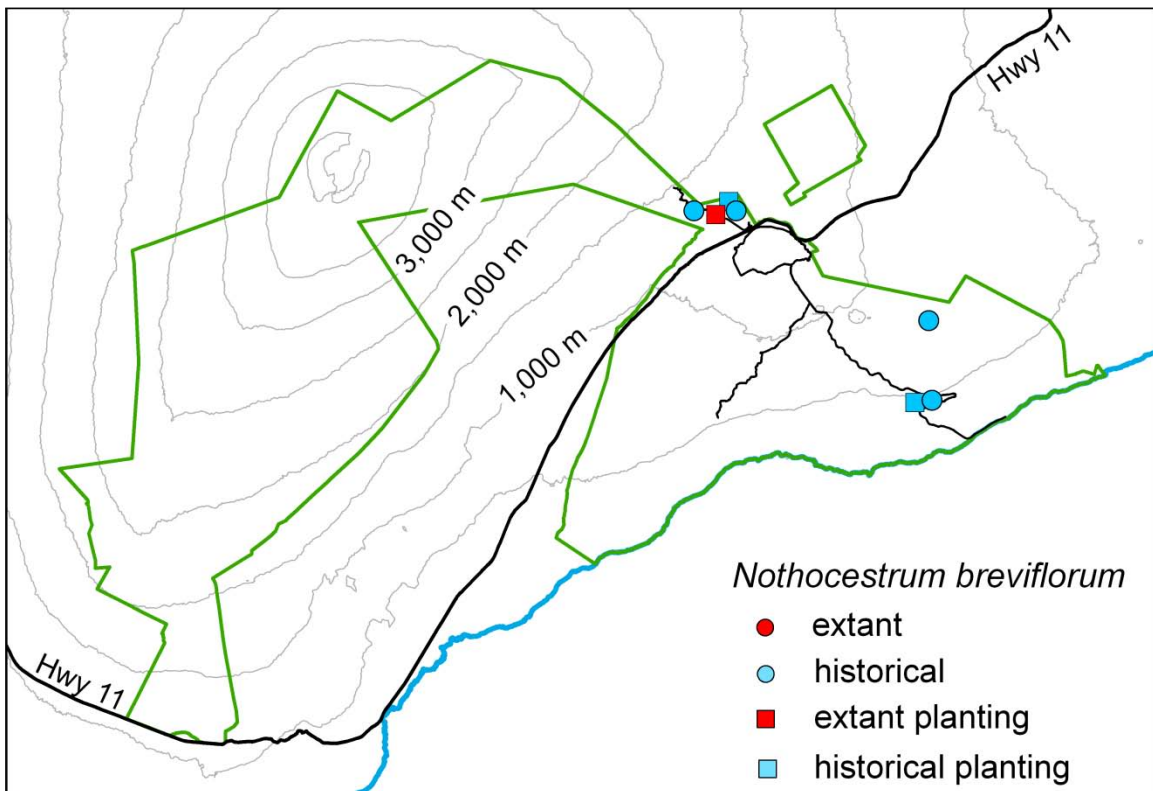
SIMILAR SPECIES: The only plant remotely similar to *Exocarpos gaudichaudii* is the related *Exocarpos menziesii*, a shrub of the subalpine zone. *E. menziesii* differs in its maroon-colored branch tips and its red fruits embedded in a yellow receptacle. The two species do not occur in the same habitat type and are separated within HAVO by an elevational gradient of more than 1,500 m.

THREATS: Fire is a threat to this species in mesic (to dry) woodlands invaded by fire-adapted, alien grasses. Alien grasses may interfere with reproduction and recruitment of the rare shrub. Firetree, or faya, and African olive infest the woodland habitat of hulumoa. Within HAVO, feral goats may have impacted and reduced the species in the past.

MANAGEMENT/RESTORATION STRATEGIES: Wildfire is suppressed throughout HAVO, and feral goats have been removed. No management actions are currently directed toward the specific habitat of this plant, although the area was formerly treated as an SEA. Invasive plant control was abandoned here in the 1990s. An attempt was made to propagate the species at HAVO, but seed germination trials were not successful (Belfield *et al.* 2011). Additional propagation work is warranted for this rare species, and it may be appropriate to locate a larger number of seed donors on the island.

REMARKS: Only two **hulumoa individuals are known from `Āinahou Ranch, but these were healthy when last visited in 2005.** These shrubs were discovered during a botanical survey of the area carried out by Natural Resources Management Division botanists in 1983 and have persisted for more than 25 years. The species may require active management, including propagation and planting within suitable protected habitat, if it is to remain a part of the **park's flora.**

CULTURAL USES/ETHNOBOTANY: None known.



^ Aiea, *Nothocestrum breviflorum*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: `Aiea

SCIENTIFIC NAME: *Nothocestrum breviflorum*

FAMILY: Solanaceae (Nightshade Family)

SYNONYMS: *Nothocestrum breviflorum* var. *longipes*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Tree 10–12 m tall; bark smooth and light brown or gray; branches stiff and ascending. Leaves clustered at the ends of branches, alternate, thick, oblong to elliptic-oblong, 5–12 cm long and 3–6 cm wide; upper surface sparsely hairy or hairless; lower surface sparsely to densely hairy; margins entire. Flowers borne on short, woody, axillary spurs; flower stalks (pedicels) 4–10 mm long; calyx 6–11 mm long with dentate margin; corolla greenish-yellow or greenish-white, with four hairy lobes; corolla tube only slightly extending beyond calyx; four stamens not extended beyond corolla; style short. Fruits are orange berries globose to oblong, 6–8 mm long, enclosed by the calyx. Seeds are small (Wagner *et al.* 1999). Phenology: Fruit produced in spring and summer (Culliney and Koebele 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to leeward Hawai`i Island at 550–1,830 m (1,800–6,000 ft) elevation; **distributed from Waimea, Kohala to Ka`ū District (Wagner *et al.* 1999)**; formerly large trees were common at Pu`uwa`awa`a (Rock 1913). Wagner *et al.* (1999) suggested that **plants from Kīpuka Puauulu represented cultivated material, but Rock collected the species there prior to its inclusion in the national park and before propagation efforts (Mueller-Dombois and Lamoureux 1967).**

HAVO DISTRIBUTION: Reported from Kealakomo `a`ā flow near Nāulu Forest, along Nāpau Trail, Kīpuka Puauulu, and Kīpuka Kī (Fosberg 1966). The species was lost from all historical sites at HAVO and exists in the park today only as plantings at Kīpuka Puauulu.

HABITAT: Lowland dry forest to montane mesic forest. In HAVO reported from dry forest near 500 m to mesic forest at 1,310 m (4,300 ft).

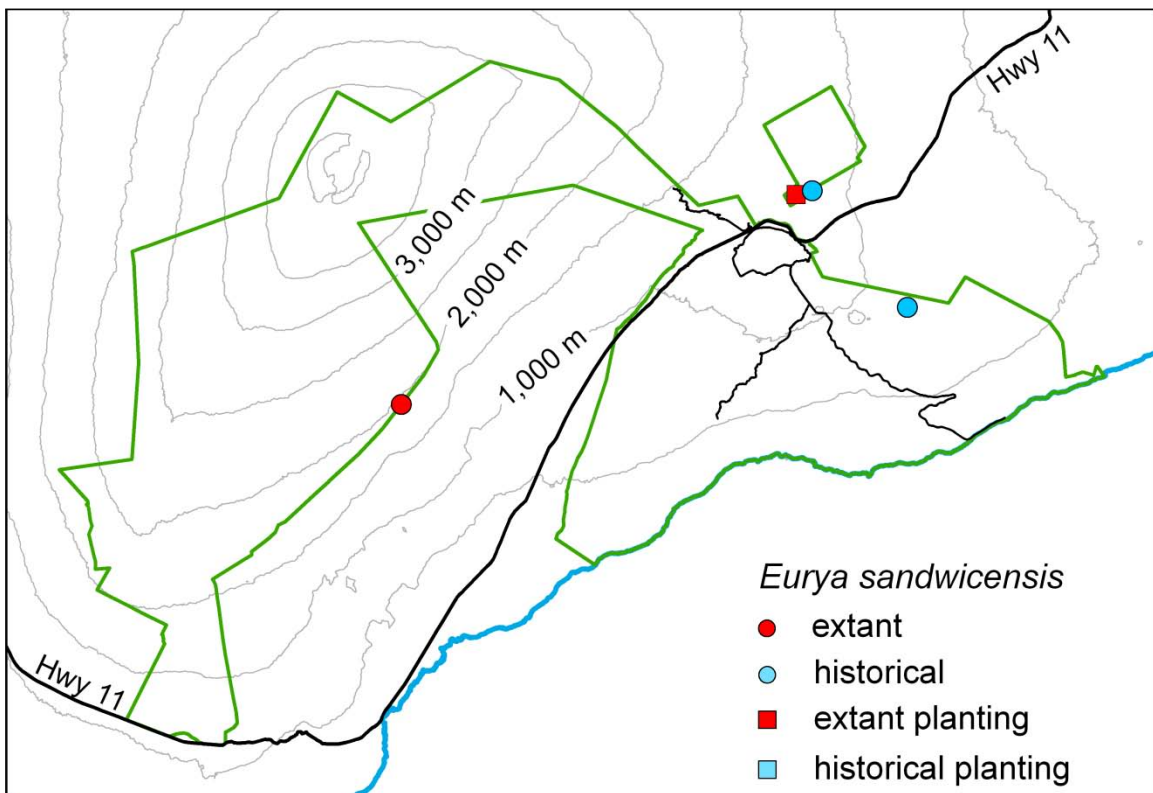
SIMILAR SPECIES: The related *Nothocestrum longifolium* is very similar in overall appearance to *N. breviflorum* and may occur in the same habitat, at least at Kīpuka Puauulu and Kīpuka Kī. The species may be distinguished by their fruits; *N. breviflorum* fruits are round and enclosed by the persistent calyx, while *N. longifolium* fruits are oblong and usually only partly enclosed by the calyx. *Nothocestrum longifolium* also typically has longer leaves that are not all clustered near branch tips; its flowers are not borne on woody spurs. Young plants are difficult to distinguish.

THREATS: Cattle and feral goats have impacted this species. Fire is also a threat in forest invaded by alien fire-prone grasses. Rats and alien invertebrates may destroy seeds. Unnaturally low population size may reduce reproduction (U.S. Fish and Wildlife Service 1996).

MANAGEMENT/RESTORATION STRATEGIES: Cattle, feral goats, and invasive alien plants have been removed from the habitat of this species in HAVO. **Nāulu Forest, Kīpuka Puauulu, and Kīpuka Kī are managed as Special Ecological Areas (SEAs). Fires are suppressed. Past plantings at Kīpuka Puauulu (1954–1959) did not persist (Morris 1967). More than 120 plants from Pu`uwa`awa`a seeds were placed at Kīpuka Puauulu in 2003; about half the plantings survived for 2–5 years. A planting of 15 at Nāulu was not successful after five years (Belfield *et al.* 2011). The feasibility of large-scale rat reduction has not been investigated.**

REMARKS: **The species was not found during surveys of Kīpuka Puauulu and Kīpuka Kī in the 1990s (L. Pratt and L. Abbott, unpublished data).** The tree has also been lost from Kealakomo and the East Rift (Abbott and Pratt 1996, Pratt *et al.* 1999).

CULTURAL USES/ETHNOBOTANY: Krauss (1993) reported that the wood was used by Hawaiians for gunwales of canoes; the soft wood of `aiea is not useful for building timber.



Ānini, *Eurya sandwicensis*
Photo: Linda Pratt, USGS, PIERC

COMMON NAME: **Ānini**

SCIENTIFIC NAME: *Eurya sandwicensis*

FAMILY: Theaceae (Tea Family)

SYNONYMS: *Eurya degeneri*; *E. sandwicensis* f. *grandifolia*, *E. s.* var. *prostrata*; *Tern-stroemiopsis sandwicensis*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Small tree or shrub; dioecious or rarely monoecious. Leaves alternate, closely spaced on branch, oblong, elliptic, or obovate, 3.5–9 cm long and 1.5–4 cm wide; veins reddish, obvious reticulated veins on lower surface; upper surface without hairs, lower surface sparsely hairy on midrib; margins with small, inflexed teeth; tip of leaf rounded to acute; base of leaf heart-shaped to truncate or cuneate; petioles only 2–3 mm long. Flowers unisexual on different plants, one to two in leaf axils, nodding; sepals five, purplish-brown, thick, 3–4 mm long, enlarged to 8 mm in fruit; petals five, pale yellow to cream, fleshy, 5–6 mm long; male (staminate) flowers with 10–15 stamens; female (pistillate) flowers with five to six staminodes and three to four styles. Fruit a dark blue-black, globose berry, 7–10 mm in diameter. Seeds numerous, round to kidney-shaped (Wagner *et al.* 1999). Phenology: Unknown, but specimens in the HAVO Herbarium bore flowers in November and January.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Kaua`i, O`ahu, Moloka`i, Maui, and Hawai`i between 450 and 1,600 m (1,480–5,250 ft) elevation (Wagner *et al.* 1999). Distributed on the windward slopes of Hawai`i Island. The population nearest HAVO is within Pu`u Maka`ala Natural Area Reserve.

HAVO DISTRIBUTION: **Formerly in wet forest near Makaopuhi Crater on Kīlauea’s East Rift (Fosberg 1966) and in `Ōla`a Forest, near the Koa Unit boundary with privately-owned pastureland (HAVO Herbarium). Recently noted at Kahuku Unit in wet forest near the northern boundary of Ka`ū Forest Reserve (Benitez *et al.* 2008). Planted in `Ōla`a Small Tract.**

HABITAT: Montane wet to mesic forests; on older islands found on windswept ridges.

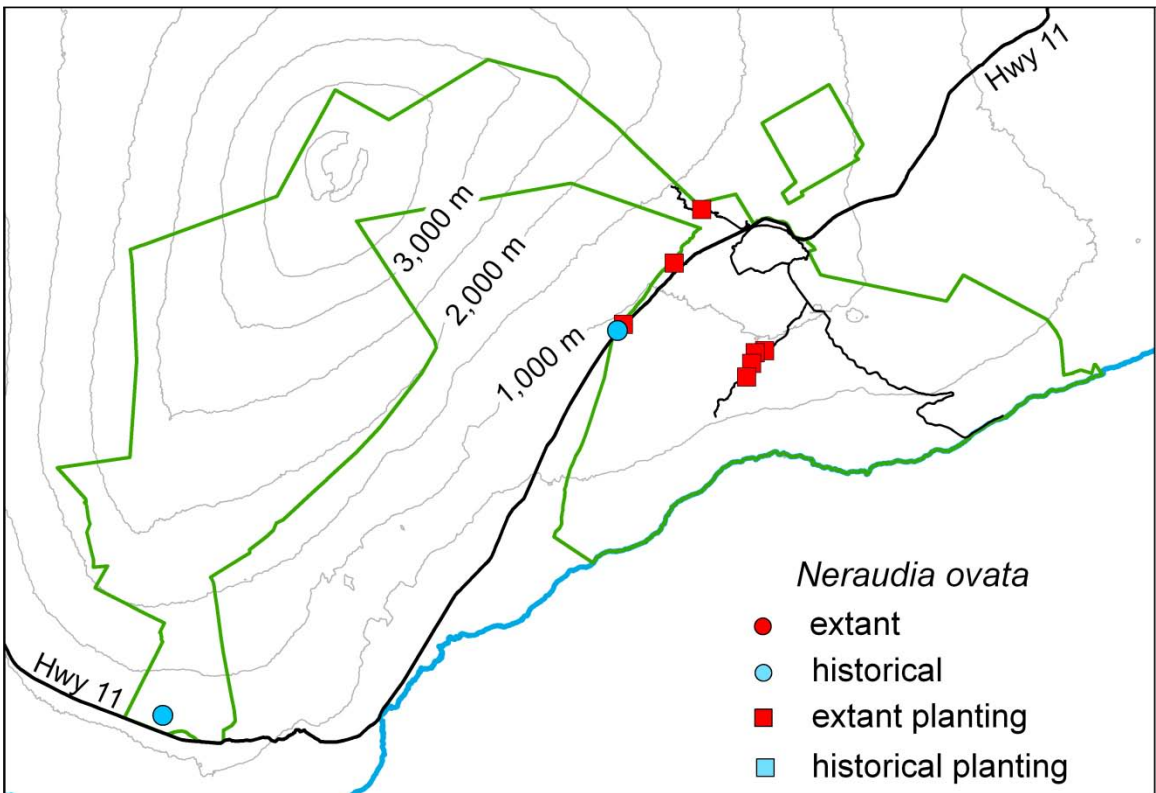
SIMILAR SPECIES: Ānini foliage is superficially similar to the unrelated `ōhelo kau lā`au (*Vaccinium calycinum*), a common shrub of wet forests. This `ōhelo is stiffly erect rather than sprawling, and has leaves that turn bronze and drop in the fall and winter. `Ōhelo bears greenish, urn-shaped flowers, followed by round, red berries that retain the persistent remains of the calyx lobes.

THREATS: Feral pigs are a potential threat to ānini and other understory plants in unprotected wet forests. Small population size may make reproduction difficult as the species is dioecious (male and female flowers on separate plants).

MANAGEMENT/RESTORATION STRATEGIES: The habitat of ānini in `Ōla`a is pig-free, and the most invasive alien plant species are controlled in the western management units. A few ānini (seven) were recently planted and most (70%) persist in the fenced Small Tract of `Ōla`a Forest (Belfield *et al.* 2011). The species is a candidate for re-introduction to the Nāhuku (Thurston Lava Tube) and East Rift Special Ecological Areas (SEA) (Loh 2008a). Both SEAs are managed to remove feral pigs and control invasive alien plants. Further **surveys may be required at Kahuku Unit to establish the size and extent of the ānini population there.**

REMARKS: This rare shrub species appears to have been lost from the original section of HAVO during **the last 50 years. Specimens document the former presence of ānini within both `Ōla`a Forest and the East Rift SEA, but recent surveys failed to find the species (Pratt and Abbott 1997, Belfield 1998, Pratt *et al.* 1999).**

CULTURAL USES/ETHNOBOTANY: None known.



Ovate ma`aloa, *Neraudia ovata*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Ovate ma`aloa**

SCIENTIFIC NAME: *Neraudia ovata*

FAMILY: Urticaceae (Nettle Family)

SYNONYMS: *Boehmeria ovata*; *Neraudia cookii*, *N. melastomaefolia* var. *ovata*, *N. pyrifolia*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1996

DESCRIPTION: Small sprawling shrub; branches covered with short hairs. Leaves alternate, grayish on underside, ovate to elliptic-ovate, 4–12 cm long and 2–6.5 cm wide; upper surface sparsely covered with appressed hairs; lower surface moderately hairy; margins entire; petioles 1–2 cm long, densely hairy. Flowers unisexual in dense axillary clusters, sexes on different plants (dioecious); male flowers on short pedicels of 1 mm, with boat-shaped, four-parted calyx densely hairy, lobes 3–4.5 mm long, four stamens 2–5 mm long, anthers with white pollen; female flowers sessile, calyx lobes fused and densely hairy, apex collar-like or 3–4 toothed, stigma 4–7 mm long. Fruits are dry achenes, 2–3 mm long, covered by the fleshy calyx (Wagner *et al.* 1999). Phenology: Unknown; plantings in HAVO flower in the winter.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to leeward Hawai`i Island between 300 and 1,470 m (980–4,820 ft) elevation (Wagner *et al.* 1999). **Formerly distributed from North Kona to Ka`ū District; now apparently restricted to three populations at Kaloko, Pōhakuloa Training Area (PTA), and between PTA and Pu`u Anahulu (U.S. Fish and Wildlife Service 1998c).**

HAVO DISTRIBUTION: Natural population extirpated from HAVO; formerly a component of dry woodland near the western boundary at 915 m (3,000 ft) elevation (Fosberg 1966). Recently planted near the presumed original site and an additional site on the park boundary, **as well as at Kīpuka Kī and several sites along Hilina Pali Road.** Historically known from a collection at Kahuku, although the label information was not specific as to the site (Benitez *et al.* 2008).

HABITAT: Lowland to montane dry forest, open lava flows. In HAVO, ovate ma`aloa was last seen growing in open low-stature `ōhi`a lehua woodland on rough `a`ā lava of the Ke`āmoku Flow. **At Kahuku Unit, the species was formerly found on `a`ā lava of the 1887 flow.**

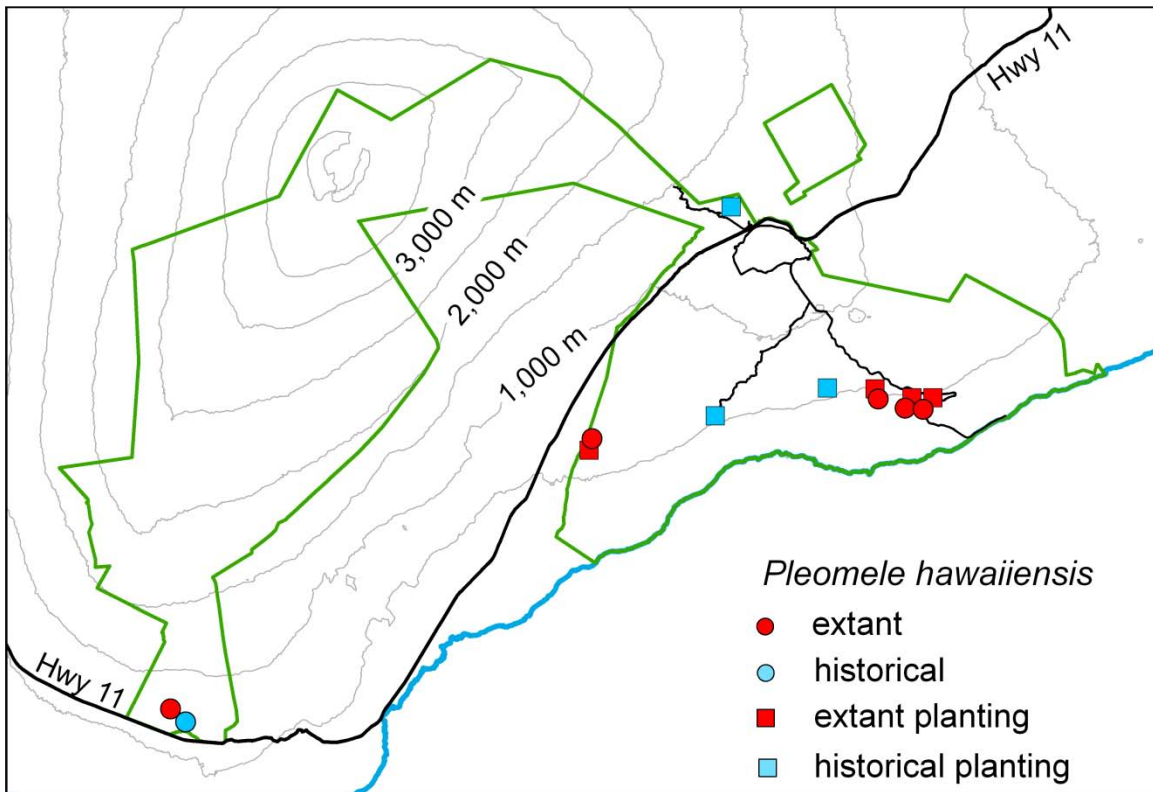
SIMILAR SPECIES: Māmaki (*Pipturus albidus*) is much like *N. ovata* but may be distinguished from *Neraudia* by its large, prominently toothed leaves with white undersides.

THREATS: Browsing by feral goats and sheep and competition with alien shrubs and grasses are probable threats to the species. Insects, particularly the spiralling whitefly, were listed as reasons for decline by the U.S. Fish and Wildlife Service (1998c). Volcanic activity is a potential threat, as is wildfire.

MANAGEMENT/RESTORATION STRATEGIES: The known former habitat of ovate ma`aloa in HAVO is **within the Ke`āmoku SEA, where** plants are protected from fire and feral ungulates. Few alien shrubs or grasses are present, and faya, silky oak, and fountain grass are controlled. This species was recently (2001–2005) planted within two **kīpuka in the Ke`āmoku SEA, as well as at Kīpuka Kī and** four sites along Hilina Pali Road. **Approximately 40% of 160 plantings at Kīpuka Kī and Ke`āmoku** survived for 5–7 years, but survival of >100 plants at the Hilina sites was poor (2%) (Belfield *et al.* 2011). Habitat exists within dry forest at Kahuku Unit to support the species when feral ungulates are removed.

REMARKS: No ovate ma`aloa plants have been found within HAVO since 1949 (Cowan 1949) or at Kahuku Unit since 1956 (Benitez *et al.* 2008), and the species was assumed extirpated from HAVO prior to re-introduction. Sources for recent re-introductions were extant plants at PTA (Belfield *et al.* 2011). The entire genus of five species is endemic to the Hawaiian Islands (Wagner *et al.* 1999).

CULTURAL USES/ETHNOBOTANY: Ma`aloa (*Neraudia*) plants were sometimes used by Hawaiians to make a coarse brown kapa or bark cloth (Abbott 1992).



Hala pepe, *Pleomele hawaiiensis*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Hala pepe**

SCIENTIFIC NAME: *Pleomele hawaiiensis*

FAMILY: Agavaceae (Agave Family); transferred to Ruscaceae (Wagner and Herbst 2003)

SYNONYMS: *Pleomele kaupulehuensis*, *P. konaensis*; also known as *Dracaena hawaiiensis*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1996

DESCRIPTION: Tree to 6 m tall, with fleshy stems. Leaves thick, sword-shaped, 23–38 cm long and <3 cm wide, tapering toward tip; arranged spirally at ends of branches. Flowers in large terminal panicle inflorescences 19–28 cm long with curved stalks 6–13 cm long; flowers on stalks 5–12 mm long, with six yellow tepals fused partway into a tube, 33–43 mm long, lobes spreading and 11–14 mm long; six stamens with anthers 4–4.5 mm long; ovary superior and three-celled, style slender, and stigma three-lobed. Fruits are red, globose berries 10–13 mm long. Seeds are one to two per fruit, 6–7 mm long. Phenology: Flowers and fruits are borne in summer (St. John 1985, Wagner *et al.* 1999).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island at elevations of 300–860 m (985–2,820 ft): **dry leeward slopes of Hualālai in North Kona, lava fields of Mauna Loa near the South Kona/Ka`ū District boundary, and in both Ka`ū and Puna Districts in HAVO.**

HAVO DISTRIBUTION: Less than 20 adult plants (natural populations) have been observed in HAVO at **Nāulu Forest, Kealakomo kīpuka, Poliokeawe Pali, and in the Great Crack along the western park boundary (Abbott and Pratt 1996).** Plantings persist at **Nāulu, Kealakomo, Poliokeawe, and the Great Crack.** Hala pepe was historically collected in or near Kahuku, but no plants were found during a recent plant inventory of the unit (Benitez *et al.* 2008). In 2010, a single tree was discovered at Kahuku east of the 1887 flow (C. Cornett, pers. comm.), and two others were later found nearby.

HABITAT: Lowland dry and mesic forests of lama and `ōhi`a lehua; in HAVO relictual populations occur on steep pali (cliff) slopes and in the rocky talus of the Great Crack.

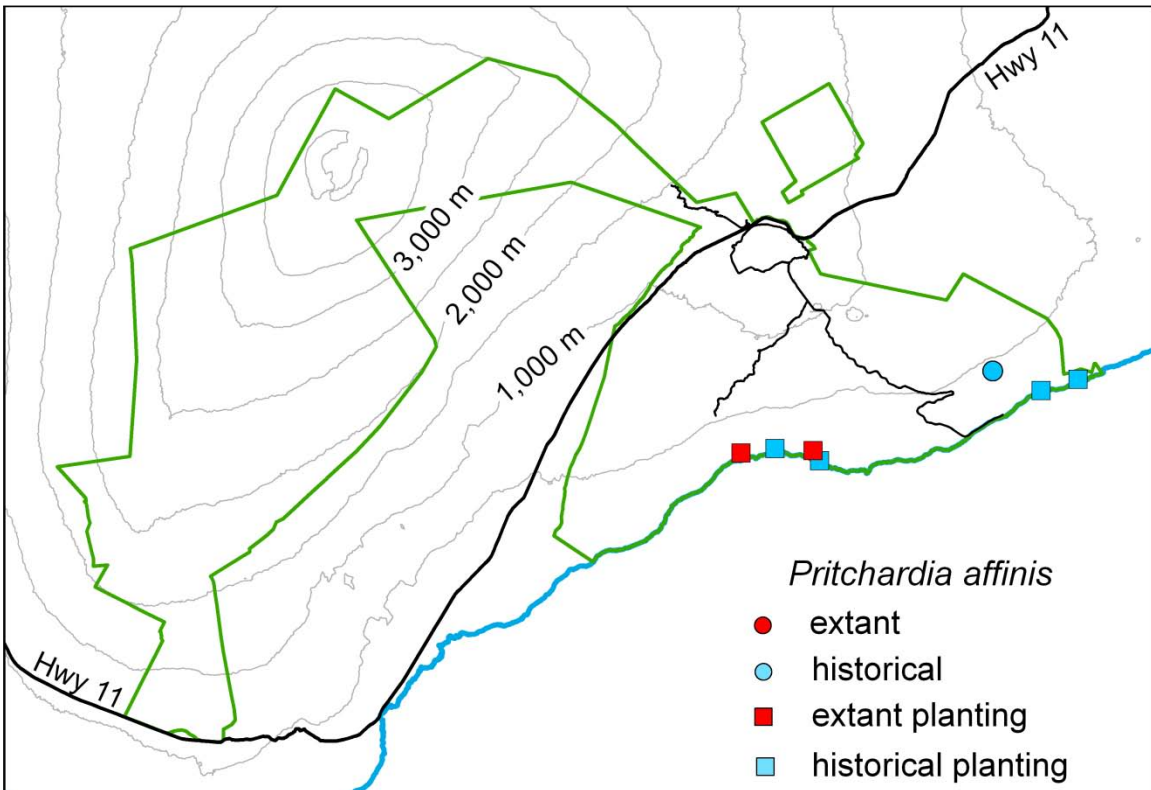
SIMILAR SPECIES: This hala pepe is unmistakable in its dry forest habitat, although it resembles several ornamental species of *Pleomele* or money tree planted in urban areas.

THREATS: Rats are known seed predators of this and other hala pepe species. Feral goats are threats in unprotected areas. Alien plants, such as Asian swordfern, lantana, silky oak, and Christmas berry, have dense cover near plants in the park and may interfere with reproduction. Fire spread by alien grasses is a potential threat to this and other dry forest species (U.S. Fish and Wildlife Service 1998c). Insects may attack planted hala pepe (Culliney and Koebele 1999).

MANAGEMENT/RESTORATION STRATEGIES: Feral goats were removed from HAVO lowlands, and fires are suppressed. Selected alien plants have been controlled at **Nāulu and Kealakomo. A few individuals were planted in the 1970s at Nāulu, Poliokeawe, and the Great Crack (N. Zimmer, unpublished data).** Earlier (1924, 1952–1955) plantings of hala pepe at **Hilina Pali, `Āinahou, and Kīpuka Puau** did not survive (Morris 1967). Hala pepe seedlings were recently (2001–2003) planted with more than 50 placed **in each of Nāulu and Kealakomo; survival was very good (>80%) after seven to nine years (Belfield *et al.* 2011).** Hala pepe may be suitable for restoration to lower dry forests at Kahuku Unit when they are protected from ungulates. The effects of rat control on hala pepe reproduction have not been studied.

REMARKS: This species is extremely rare on the island with only 300 remaining trees (Cordell *et al.* 2008) **and is protected only at HAVO, Ka`ūpūlehu in Kona, and Manukā, Ka`ū.** For many years, all Hawaiian *Pleomele* were together in one species, *P. aurea*, now considered endemic to Kaua`i. In a 1985 monograph, St. John recognized three species on Hawai`i Island. The most recent treatment (Wagner *et al.* 1999) considered all Hawai`i Island plants to be *P. hawaiiensis*.

CULTURAL USES/ETHNOBOTANY: Hawaiians carved idols from hala pepe wood and cut branches to decorate the altar of the goddess Laka, patroness of the hula (Rock 1913).



Loulu, *Pritchardia affinis*
 Photos: Linda Pratt, USGS, PIERC

COMMON NAME: **Loulu**

SCIENTIFIC NAME: *Pritchardia affinis*

FAMILY: Arecaceae (Palm Family)

SYNONYMS: *Pritchardia affinis* var. *gracilis*, *P. a.* var. *halophila*, *P. a.* var. *rhopalocarpa*. *Pritchardia maideniana* is either the correct name or a synonym (Hodel 2007).

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Small palm tree, 10–25 m tall. Trunk smooth, with longitudinal grooves and obscure leaf scar rings. Leaves large, fan-shaped, deeply parted into numerous segments, upper part of segments drooping; with soft pink wool on the underside of the stout petiole, extending onto leaf blade; upper side dark green, lacking scales; underside pale green with scattered yellowish scales. Flowers perfect, borne in pendulous, panicle inflorescences arising among the leaves; large bracts at base of inflorescence and small bracts near flowers; inflorescence branchlets with zigzags between flowers; individual flowers with a three-parted, cuplike calyx and three petals that fall off as the flower expands; six stamens with flattened filaments, fused into a column at base; three carpels with fused styles and a three-parted stigma; only one carpel develops into a fruit. Fruits globose, >2 cm in diameter, brown to black at maturity, containing one large seed beneath a fleshy exocarp, or outer layer (Wagner *et al.* 1999).

Phenology: Other species of *Pritchardia* show little seasonality in fruit production (Chapin *et al.* 2007).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to leeward Hawai`i Island, found mostly on the coast, but also in gulches to an elevation of 600 m (1,970 ft) (Wagner *et al.* 1999).

HAVO DISTRIBUTION: Until recent fires and lava flows, there was one group of trees on the Kalapana Trail at 300 m (985 ft) elevation in the eastern park lowlands and plantings at Waha`ula and Kamoamoia **on the coast. Early plantings were also made at Keauhou and Halapē. Recently planted at coastal sites east of Ka`aha and at Keauhou.**

HABITAT: Most remaining *P. affinis* trees on Hawai`i Island are growing in coastal habitats near the shore or at anchialine pools. The palm also grows in lowland gulches. In HAVO, the only known adult trees were **found in a kīpuka of native and alien trees near a former habitation.**

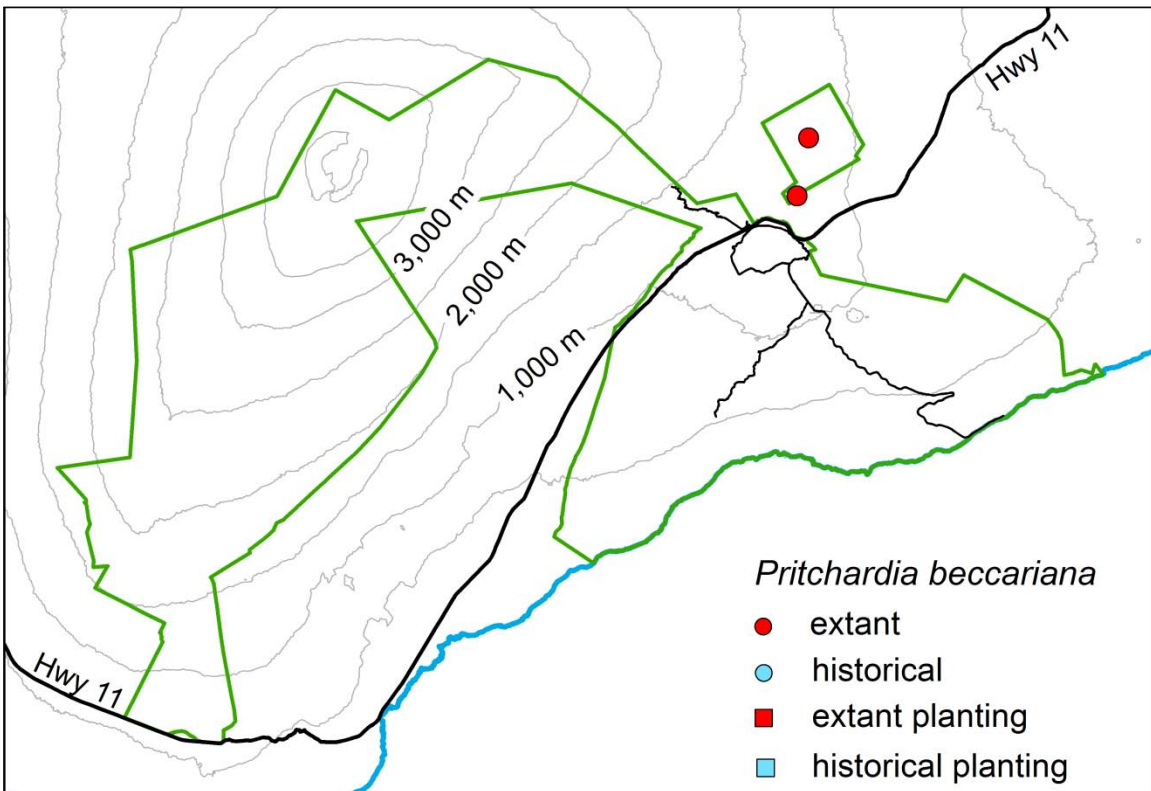
SIMILAR SPECIES: Only one other loulu palm occurs in HAVO; *Pritchardia beccariana*, a tall palm **restricted in HAVO to the wet montane `Ōla`a Forest.** *Pritchardia beccariana* differs from the coastal species *P. affinis* in its large, unsymmetrical, ovoid fruit >3 cm long.

THREATS: Rats are known to be seed predators of loulu species (Male and Loeffler 1997, Pérez *et al.* 2008). Fire is a potential threat.

MANAGEMENT/RESTORATION STRATEGIES: Wildfires are suppressed at HAVO. Recent plantings of loulu were made on coastal talus slope at Ka`aha in 2000, and 9% survived >10 years. More than 50 young trees were planted at coastal Keauhou in 2008, and 19% survived two years (Belfield *et al.* 2011). **Plantings at Keauhou and Halapē in the 1970s** (N. Zimmer, unpublished data) did not persist. The feasibility of reducing rat populations at coastal plantings has not been studied. If this loulu is to remain part of the flora of HAVO, it may require continued restoration efforts at appropriate coastal sites and effective control of seed predators.

REMARKS: It is likely that many, if not most, of remaining trees on the island are planted, as *P. affinis* was often cultivated near Hawaiian houses (Beccari and Rock 1921). The loulu palms of the Kalapana area were formerly recognized as var. *halophila*, a small tree that grew among rocks near the shore. Hodel (2007) recently transferred *P. affinis* to *P. maideniana*.

CULTURAL USES/ETHNOBOTANY: Hawaiians consumed loulu fruits; leaves used for thatching and other purposes (Beccari and Rock 1921). Leaves were used to thatch heiau to honor fish gods (Abbott 1992).



Loulu, *Pritchardia beccariana*
 Photos: Linda Pratt, USGS, PIERC

COMMON NAME: **Loulu**

SCIENTIFIC NAME: *Pritchardia beccariana*

FAMILY: Arecaceae (Palm Family)

SYNONYMS: *Pritchardia beccariana* var. *giffardiana*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Medium-sized palm tree, 16–19 m tall. Trunk smooth, with longitudinal grooves and close rings. Leaves large, fan-shaped, deeply parted into numerous segments, upper part of segments drooping; with stout petiole 1.2–3 m long; upper side of leaf green, lacking scales; underside green with scattered small fringed scales. Flowers perfect, borne in pendulous inflorescences arising among the leaves; inflorescence to 1.5 m long, made up of three or more panicles about 30 cm long; inflorescence branchlets with zigzags between flowers; individual flowers with a three-parted, cuplike calyx and three petals that fall off as the flower expands; six stamens with flattened filaments fused into a column at base; three carpels with fused styles and a three-parted stigma; only one carpel develops into a fruit. Fruits ovoid to globose, asymmetrical, >3 cm long and 2.5–3 cm in diameter, pointed at the far end, brown to black at maturity, containing one large seed beneath a fleshy exocarp or outer layer (Beccari and Rock 1921, Wagner *et al.* 1999). Phenology: Unknown; other species of *Pritchardia* show little seasonality in fruit production (Chapin *et al.* 2007).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to windward Hawai`i Island between 1,100 and 1,270 m (3,610–4,165 ft) **elevation, particularly common in the Kīlauea and Glenwood regions** (Wagner *et al.* 1999).

HAVO DISTRIBUTION: **In HAVO this palm is restricted to `Ōla`a Forest, where it is scattered throughout both the Large Tract and Small Tract.**

HABITAT: This loulu is a wet forest species, and in HAVO its habitat is montane wet **`ōhi`ā lehua/hāpu`u forest**.

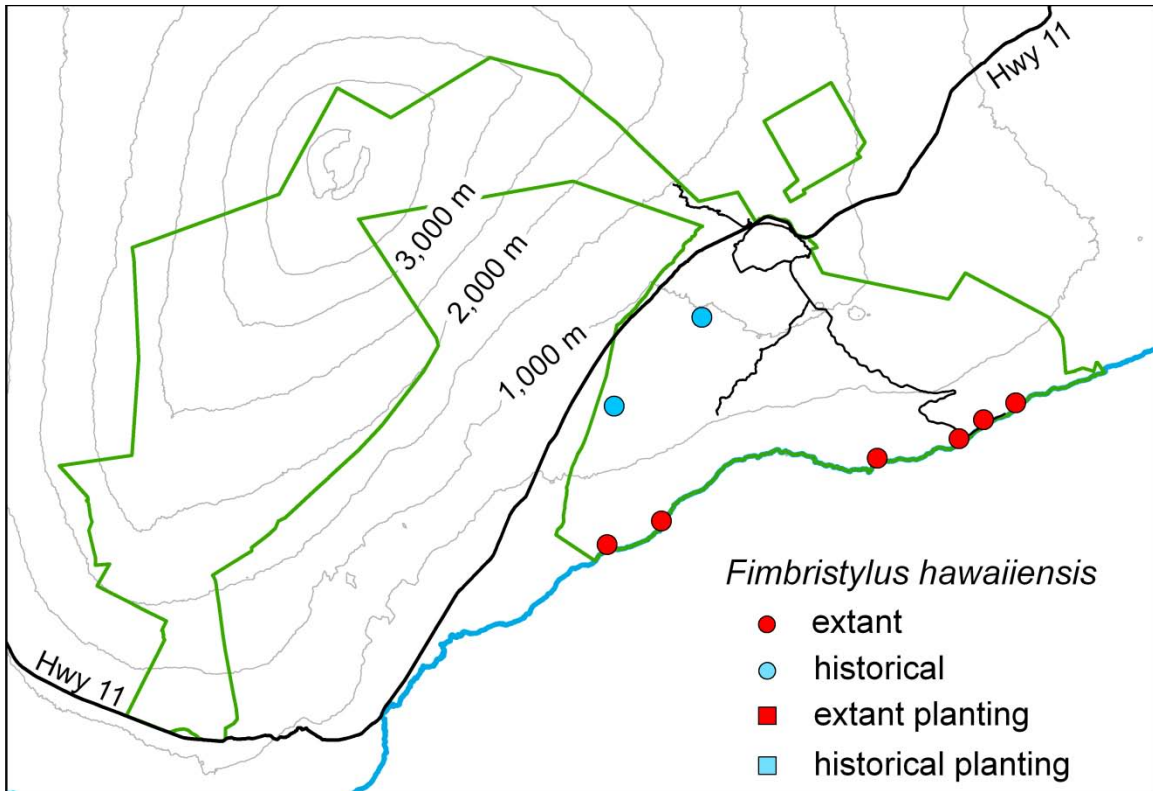
SIMILAR SPECIES: Only one other loulu palm occurs in HAVO, *Pritchardia affinis*, a palm restricted in HAVO to the coast and lowlands; since recent lava flows, it is found in the park only at planting sites. *Pritchardia affinis* is a smaller palm, which has symmetrical, round fruit about 2 cm in diameter.

THREATS: Rats are known to be seed predators of loulu species in general (Pérez *et al.* 2008, Male and Loeffler 1997). Feral pigs have also been observed to be fruit predators and may damage young loulu seedlings by their rooting activities (Beccari and Rock 1921). Insects attack and sometimes destroy the fruit of this loulu.

MANAGEMENT/RESTORATION STRATEGIES: Loulu palms are protected from feral pigs within five pig-free **fenced enclosures within `Ōla`a Forest**. Invasive alien plants are also controlled within sections of the enclosure management units. The feasibility of reducing rat populations on a large scale within wet montane forests has not been well studied. This loulu species has not been the target of restoration or planting efforts.

REMARKS: **Since the construction of fences and removal of feral pigs in units of `Ōla`a Forest, which began in the early 1980s, loulu seedlings have begun to appear near adult palm trees. The palm plants appear to grow slowly, and the `Ōla`a loulu population consists of tall adult trees and young plants with no palms of intermediate size.**

CULTURAL USES/ETHNOBOTANY: Hawaiians consumed young loulu fruits of several species as food; leaves were used for thatching and other purposes (Beccari and Rock 1921).



Hawaiian fringed sedge, *Fimbristylis hawaiiensis*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Hawaiian fringed sedge**

SCIENTIFIC NAME: *Fimbristylis hawaiiensis*

FAMILY: Cyperaceae (Sedge Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Species of Concern, former Candidate Threatened/Endangered

DESCRIPTION: Small terrestrial, perennial sedge, 9–17 cm tall. Leaves few, wiry, and slender, less than 1 mm wide, shorter than the stem. Inflorescence simple and open, with rays 0.5 to 1 cm long; one to two bracts shorter than the inflorescence; spikelets one to five, ovoid to cylindrical, 5–9 mm long and 2–2.5 mm wide. Fruits are achenes (small, dry, single-seeded fruit), pale brown, glossy, and lenticular in shape, less than 1 mm long and wide, with a minute reticulate pattern (Wagner *et al.* 1999). Phenology: Plants are often seen fertile; specimens in the HAVO Herbarium bore fruits in fall and winter.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to Hawai`i Island, usually in dry coastal areas at elevations of 10 to 70 m (33–230 ft). Formerly thought to be restricted to HAVO (Wagner *et al.* 1999), but now known to occur in North Kona District, in and near Kaloko-Honokōhau National Historical Park.

HAVO DISTRIBUTION: Concentrations at Ka`ena Point and east of Pu`u Loa; may be found at other sites along the coastal portion of the Chain of Craters Road from Lae `Apuki to Ka`ena Point; scattered individuals near `Āpua Point, coastal Kamo`oali`i and Kū`ē`ē; and previously reported from the Great Crack and the Ka`ū Desert (Fosberg 1966).

HABITAT: Sparsely vegetated areas of grass and shrubs on pāhoehoe substrates in dry coastal lowlands.

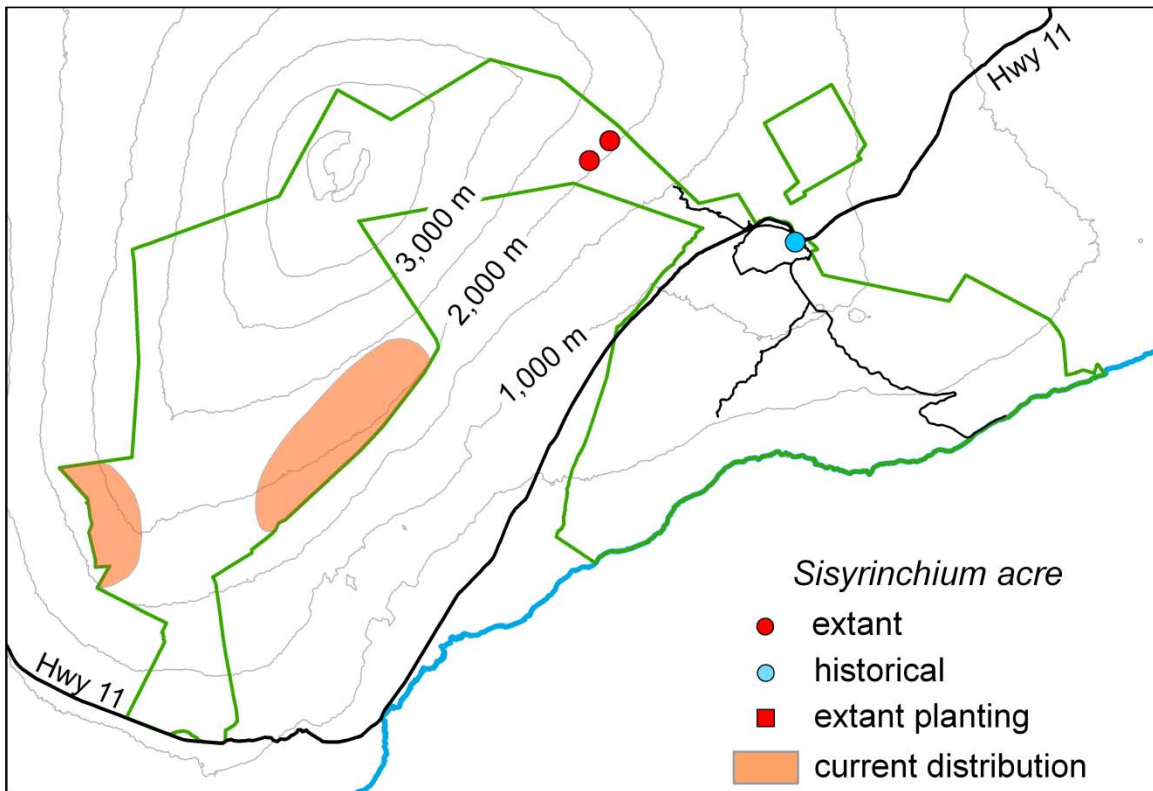
SIMILAR SPECIES: The native sedge *Fimbristylis dichotoma* is similar in appearance, although it is a larger plant with bracts longer than the inflorescence and numerous spikelets per inflorescence. The alien sedge *Bulbostylis capillaris* shares the same habitat with *F. hawaiiensis*, but may be distinguished by its fine, soft, yellow or orange leaves and many spikelets per inflorescence.

THREATS: A potential threat is the loss of habitat from invasive alien grasses and sedges. Wildfire is unlikely in the sparsely vegetated habitat of this rare sedge.

MANAGEMENT/RESTORATION STRATEGIES: No management is specifically directed at Hawaiian fringed sedge, but feral goats have been removed from the **park's coastal lowlands. Fires are suppressed** throughout HAVO. Several coastal sites within the range of the sedge are being augmented with missing native plants to restore lost biodiversity of coastal plant communities. Hawaiian fringed sedge has not been a target of propagation or restoration efforts.

REMARKS: In a recent coastal lowland survey, Hawaiian fringed sedge was found to be patchily **distributed along the HAVO coastline from Lae `Apuki to Kū`ē`ē, a distance of more than 32 km.** Several hundred plants were counted, and the species was monitored for five years in 20 small, circular plots at Pu`u Loa and Ka`ena Point (L. Pratt, unpublished data). Because the Hawaiian fringed sedge is inconspicuous and difficult to distinguish from other sedges, there are likely more plants and extant populations than are currently known.

CULTURAL USES/ETHNOBOTANY: None known.



Mau`u lā ili, *Sisyrrinchium acre*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Mau`u lā`ili**

SCIENTIFIC NAME: *Sisyrinchium acre*

FAMILY: Iridaceae (Iris Family)

SYNONYMS: None

FEDERAL AND STATE STATUS: Species of Concern (federal), no status (state of Hawai`i)

DESCRIPTION: Herb 15–30 cm tall, terrestrial, bluish-green. Leaves basal, half as long to the same length as the flowering stalk, 3–4 mm wide, smooth. Flowers borne in small groups on tall stalks, surrounded by two leafy bracts (spathe) 18–28 mm long; flowers open with six tepals (sepals and petals the same), yellow, 6–10 mm long, spreading; stamens three, filaments 2–3 mm long, anthers 2–3 mm long; style divided into three branches, 3 mm long. Fruits are three-parted capsules, 6–8 mm long and 5 mm wide, nodding. Seeds are numerous, tiny, <1 mm, black, round, and slightly flattened (Wagner *et al.* 1999). Phenology: Produces flowers and fruits in the summer, based on specimens in the HAVO Herbarium.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Endemic to East Maui and Hawai`i between 1,550 to 2,950 m (5,080–9,680 ft) elevation; also reported at lower elevations.

HAVO DISTRIBUTION: Widespread in subalpine shrubland and forest at Kahuku Unit, on both the east and west slopes of Mauna Loa (Benitez *et al.* 2008). Less common on Mauna Loa Strip, above 1,710 m (5,600 ft) elevation; most recently observed plants were growing at 2,010 and 2,135 m (6,600–7,000 ft) in Kīpuka Mauna`iu and Kīpuka Kulalio (Belfield and Pratt 2002). Degener (1975) reported mau`u lā`ili near the park entrance in 1930.

HABITAT: Subalpine dry shrubland and bog edges; in HAVO plants are found in subalpine shrubland of scattered `ōhi`a lehua trees and native shrubs, such as pūkiawe, `ōhelo, and `a`ali`i.

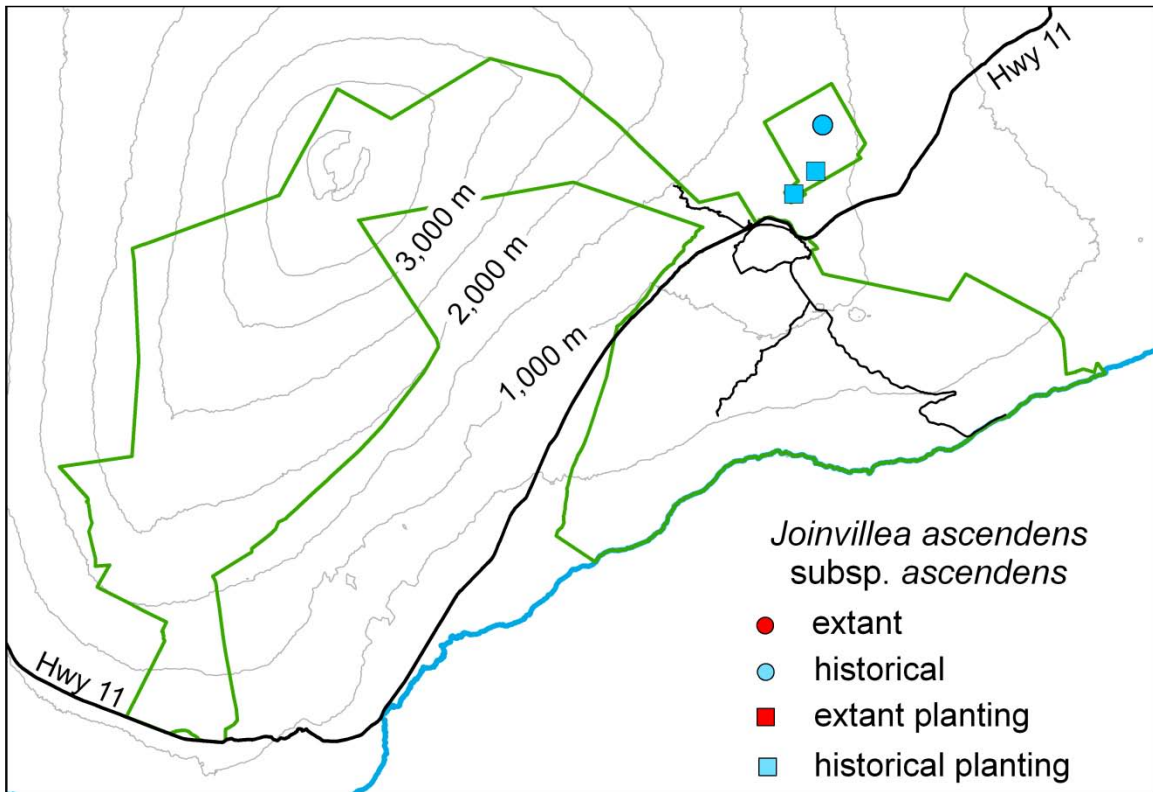
SIMILAR SPECIES: Mau`u lā`ili is unmistakable when flowering. When sterile, it is similar in form to many alien grasses. Mau`u lā`ili may be identified when sterile by its bluish-green color and its flattened leaves held upright in one plane.

THREATS: Alien grasses have been identified as potential competitors with mau`u lā`ili on Maui (L. Loope, pers. comm.). Feral goats, sheep, and pigs may threaten the species in unprotected areas, although mouflon sheep do not seem to damage the plant at Kahuku Unit.

MANAGEMENT/RESTORATION STRATEGIES: Known populations of mau`u lā`ili are protected within the alpine and upper units of the Mauna Loa Special Ecological Area, which have been fenced to exclude feral goats, pigs, and mouflon sheep. Control of common mullein, an alien biennial herb found within mau`u lā`ili habitat, has been studied for feasibility (Loh *et al.* 2000). Mau`u lā`ili has not been the target of planting programs. It is unlikely that mau`u lā`ili requires re-introduction except at the lower extent of its range, but monitoring of park populations to determine status and trends would be useful. The lower Mauna Loa Road between Highway 11 and Kīpuka Puauulu may be an appropriate planting site, based on Degener's (1946, 1975) accounts of park plants. There are no effective large-scale control methods for dense alien grasses that infest the habitat of mau`u lā`ili.

REMARKS: The species was formerly common near Kīlauea (Degener 1946), and now it appears to be reduced in range within the park and restricted to higher elevations of Mauna Loa.

CULTURAL USES/ETHNOBOTANY: Hawaiians used the sap of this plant to produce a blue stain in tattoos (Degener 1946) and for temporary tattoos (Degener 1975).



^ Ohe, *Joinvillea ascendens* subsp. *ascendens*
Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: `Ohe

SCIENTIFIC NAME: *Joinvillea ascendens* subsp. *ascendens*

FAMILY: Joinvilleaceae (Joinvillea Family)

SYNONYMS: *Joinvillea adscendens*, *J. gaudichaudiana*

FEDERAL AND STATE STATUS: Candidate Endangered Species

DESCRIPTION: Large grass-like perennial herb, 1.5–5 m tall. Stems hollow except at nodes. Leaves narrow with prominent pleats, 45–80 cm long and 4.5–16 cm wide, leaf surfaces with scattered bristles and small hairs on lower surfaces. Inflorescence a panicle of pyramidal shape, 10–40 cm long, with small flowers. Flowers with six tepals in two series, ovate to round-ovate, 2–4 mm long. Fruits drupe-like, three-sided, 3–6 mm in diameter, green maturing to reddish-orange, long persistent on plant. Seeds one to three per fruit, round and wrinkled (Wagner *et al.* 1999). Phenology: Unknown.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Kaua`i, O`ahu, Moloka`i, Maui, and Hawai`i, at elevations from 300 to 1,250 m (985–4,100 ft).

HAVO DISTRIBUTION: `Ōla`a Forest, near the middle of the Large Tract, south of the trench and crater feature, below 1,200 m elevation. There has been only one documented sighting of this species in HAVO in the 1980s (D. Kageler, pers. comm.). Recent plantings at `Ōla`a Koa Unit and Small Tract were unsuccessful. This species may have been extirpated from HAVO.

HABITAT: Lowland to montane wet forest and streambeds. On other islands, the species favors ridges (Wagner *et al.* 1999). **Habitat in HAVO is montane wet `ōhi`a lehua forest with hāpu`u understory.**

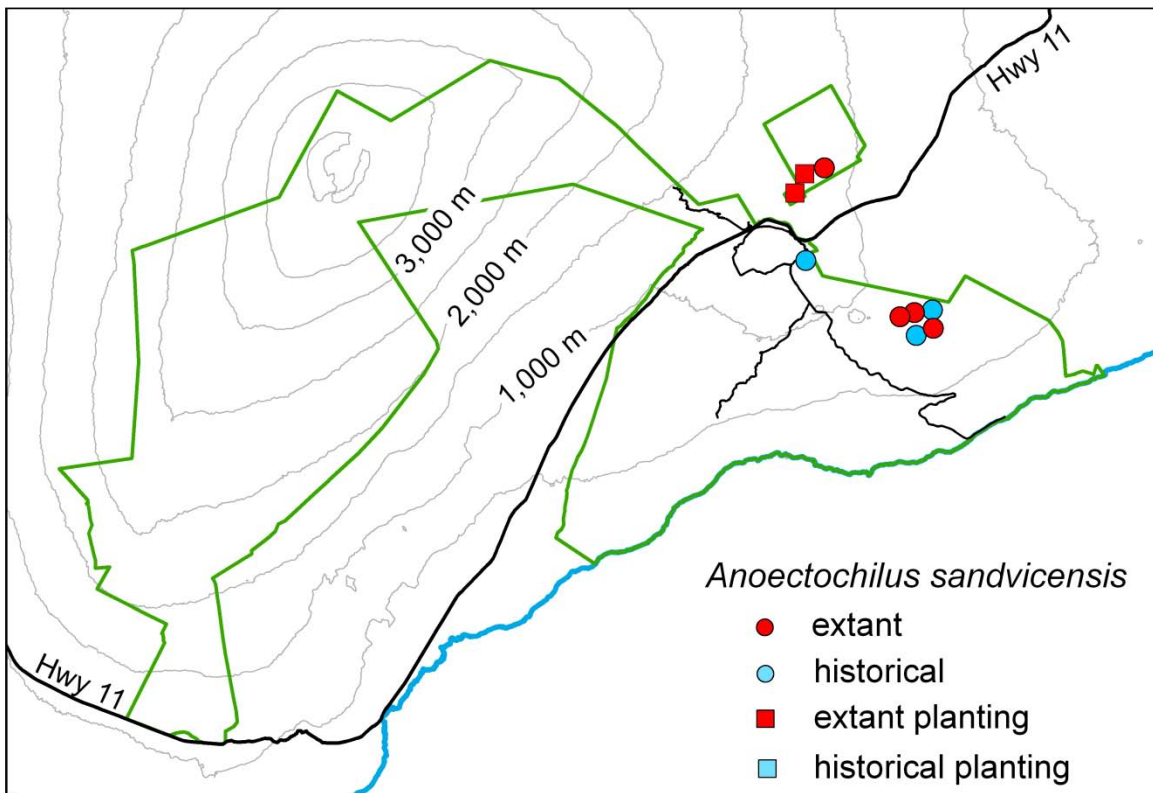
SIMILAR SPECIES: `Ohe has no close relatives among the native plants of Hawai`i, but grossly resembles the alien palmgrass (*Setaria palmifolia*). The unrelated species share the character of large, prominently pleated leaves. The invasive palmgrass may be distinguished from `ohe or *Joinvillea* by its stems covered with stiff hairs and by its large (to 60 cm) open, paniculate inflorescence with small ovate spikelets and tiny grain-like fruits.

THREATS: Feral pigs are a potential threat in the unfenced section of `Ōla`a Forest, where this plant was last seen. Problems with seed germination and seedling survival have been reported elsewhere (Wagner *et al.* 1999).

MANAGEMENT/RESTORATION STRATEGIES: The `Ōla`a Forest habitat of `ohe is fenced and free of feral animals, and the most invasive alien plant species are controlled. As part of a recent Rare Plant Stabilization Program, `ohe seeds were obtained from the adjacent `Ōla`a Forest Reserve, plants were propagated, and more than 100 seedlings were planted in the Koa Unit and Small Tract of `Ōla`a Forest. Plantings did not survive more than six to seven years (Belfield *et al.* 2011). Different planting sites, perhaps in lower-elevation wet forest, might be tried if restoration attempts are repeated in the future.

REMARKS: Hillebrand (1888) considered this plant rare more than 100 years ago. It is possibly a lowland forest species near the top of its natural range within `Ōla`a Forest. While `ohe or *Joinvillea* has not been observed in forests of the park's East Rift, its presence in the adjacent Kahauale`a Natural Area Reserve and Wao Kele o Puna (L. Pratt, pers. obs.) indicates that it may formerly have been a component of low-elevation rain forest in HAVO.

CULTURAL USES/ETHNOBOTANY: None known.



Honohono, Jewel orchid, *Anoectochilus sandvicensis*
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Honohono, Jewel orchid**

SCIENTIFIC NAME: *Anoetochilus sandvicensis*

FAMILY: Orchidaceae (Orchid Family)

SYNONYMS: *Anoetochilus apiculatus*, *A. jaubertii*; *Odontochilus apiculatus*, *O. jaubertii*; *Vrydagzynea sandvicensis*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Creeping perennial herb, usually terrestrial; rhizomes to 1 cm in diameter, rooting at nodes; leaves alternate and entire, elliptic to ovate, 4–8 cm long and 2–4 cm wide, glossy dark green above with an impressed midrib, paler beneath, petioles 1.5–3 cm long with a clasping sheath; flowers borne in loose spikes 5–15 cm long at ascending branch tips, petals and sepals pale green to yellowish-green, the labellum (enlarged, modified, lower petal) showy and pale to bright yellow, sometimes with a toothed margin, staminal column 2.5 mm tall; fruits spindle-shaped capsules 1–1.5 cm long (Wagner *et al.* 1999). **Phenology:** In `Ōla`a Forest, flowers are observed in August and September; fruits appear later in the fall and winter.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: All the main Hawaiian Islands, except Ni`ihau and Kaho`olawe, between 275 and 1,710 m (900–5,600 ft) elevation.

HAVO DISTRIBUTION: Extant in `Ōla`a Forest, Koa Unit. **Three sightings from the early 1990s in the East Rift Special Ecological Area (SEA) south of Nāpau Crater, within a small kīpuka west of Nāpau, and on the northeast slope of Kāne Nui o Hamo (Pratt *et al.* 1999).** Historically, jewel orchid was found on **the trail to Nāpau Crater and** in a nearby pit crater; these sites no longer support the species (Belfield 1998). The orchid was collected near the park entrance in 1935 (Bishop Museum Herbarium). **Recently planted in `Ōla`a Koa Unit and Small Tract.**

HABITAT: Lowland to montane wet forest.

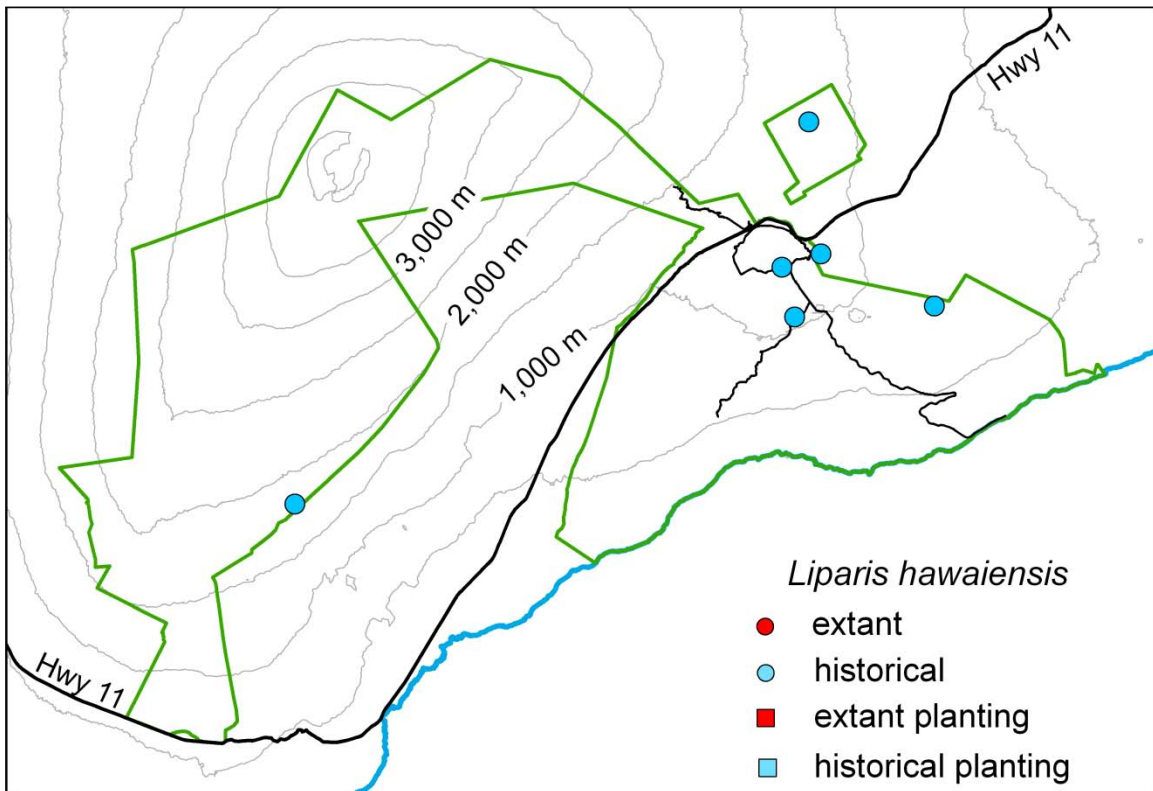
SIMILAR SPECIES: Two orchids in the same habitat as jewel orchid are superficially similar. The native `awapuhi o Kanaloa (*Liparis hawaiiensis*) has two large fleshy leaves and tiny greenish-white flowers. It is rarer in HAVO than is jewel orchid. The Chinese ground orchid (*Phaius tankarvilleae*) is larger than the native orchids and has numerous ascending, pointed, fleshy leaves and large flowers purple-brown within and white outside. Neither is likely to be mistaken for jewel orchid by a careful observer. The alien dayflower (*Commelina diffusa*) has a similar growth form to jewel orchid, but is not found within closed rain forest habitat and may be distinguished from native orchids by its small, three-parted, blue flowers.

THREATS: Feral pigs are a serious threat to the terrestrial jewel orchid. Pigs may seek out the fleshy orchid as food or destroy plants by rooting and trampling. Alien slugs are potential threats to native orchids. Species seems incapable of self-pollination, requiring an unknown insect pollinator (Kores 1980).

MANAGEMENT/RESTORATION STRATEGIES: The `Ōla`a habitat of the orchid is protected within the fenced and pig-free Koa Unit. The East Rift forests that support the species are fenced and have been managed to remove feral pigs and control invasive alien plants (Loh 2008a). Recently jewel orchids have been propagated from vegetative `Ōla`a material and planted within two fenced units of `Ōla`a Forest (Belfield *et al.* 2011). Acquisition of additional propagation material and enlargement of the pool of founder plants are warranted. Plantings of this orchid are planned for Nāhuku (Thurston) and East Rift SEAs (Loh 2008a). Research into its pollination biology might provide managers with useful information.

REMARKS: Jewel orchid will likely be lost from the park without active management. The orchid is very rare on Hawai`i Island, but it is more common in protected forests of Maui and Moloka`i.

CULTURAL USES/ETHNOBOTANY: None known. While flowers of the jewel orchid are showy, the species has not been widely cultivated by orchid growers.



Awapuhi a Kanaloa, Twayblade, *Liparis hawaiiensis*
 Photo: Art Medeiros, USGS, PIERC

COMMON NAME: **`Awapuhi a Kanaloa, Twayblade**

SCIENTIFIC NAME: *Liparis hawaiiensis*

FAMILY: Orchidaceae (Orchid Family)

SYNONYMS: *Leptorchis hawaiiensis*

FEDERAL AND STATE STATUS: Species of Concern

DESCRIPTION: Terrestrial or epiphytic perennial herb. Leaves two per pseudobulb, pale green, elliptic to elliptic-ovate, 4–10 cm long and 2–5 cm wide, with a prominent midrib sunken on upper surface and raised on lower surface, leaf tip pointed. Flowers small and pale green, borne on erect inflorescences 15–30 cm long, sepals and petals linear, except the specialized labellum, which is obovate 10–12 mm long, with irregular marginal teeth. Fruits are dehiscent capsules, obovoid, 1.5–2 cm long. Seeds are tiny and numerous (Wagner *et al.* 1999). Phenology: HAVO Herbarium specimens flowered in November.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: All the main Hawaiian Islands, except Ni`ihau and Kaho`olawe, at elevations between 490 and 1,530 m (1,610–5,020 ft).

HAVO DISTRIBUTION: `Ōla`a Forest (New Unit) (Pratt and Abbott 1997) and forests of Kīlauea and the East Rift near Nāpau Crater (Fosberg 1966). In the last 25 years twayblade was observed between the Chain of Craters Road and Keanakāko`i Crater (T. Tunison, pers. comm.), and in woodlands of the upper Hilina Pali Road (R. Loh, pers. comm.). The orchid was also sighted in the 1970s at the Kahuku Unit, near the natural silversword population at Ke a Pohina (J. Jacobi, pers. comm.) Twayblade appears to have been lost from HAVO, as all areas that supported the orchid have been recently (2000–2008) searched without success.

HABITAT: Lowland to montane wet to mesic forests; less commonly in montane seasonal woodlands. On other islands, this orchid may also be found in bogs.

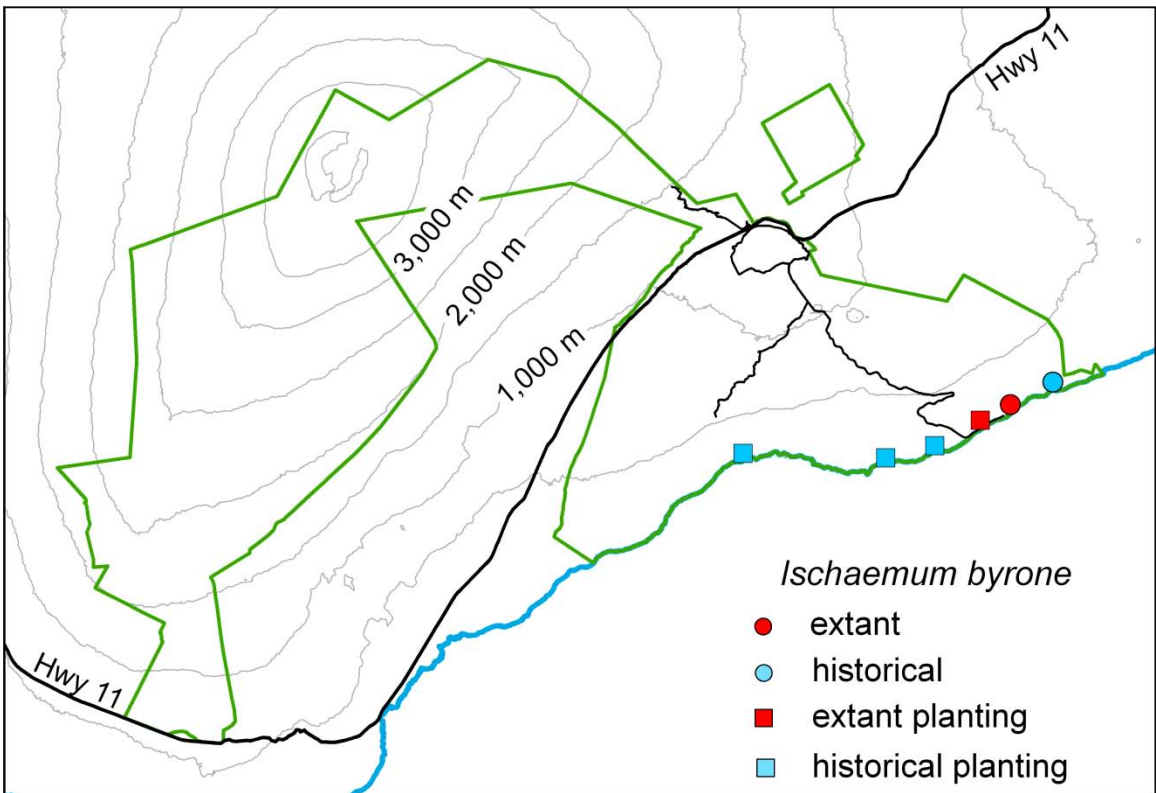
SIMILAR SPECIES: The native jewel orchid is not very similar in appearance to this twayblade or *Liparis*; jewel orchid has a creeping habit with an underground rootstock, many glossy leaves alternately arranged, and inflorescences of showy yellow or greenish-yellow flowers. The alien Chinese ground orchid (*Phaius tankervilleae*) is much larger than the native orchids, and has numerous ascending, pointed, fleshy leaves and large flowers purple-brown within and white outside.

THREATS: Feral pigs are the most serious threat to terrestrial twayblade. Loss of specialized pollinators may also be a problem for this species. The impacts of slugs and other invertebrate species are unknown.

MANAGEMENT/RESTORATION STRATEGIES: **The `Ōla`a Forest habitat of the orchid in the New Unit has been fenced but is not yet pig-free. The East Rift forests that formerly supported the species are fenced and have been managed to reduce or remove feral pigs and control invasive alien plants. The former habitat near Keanakāko`i is treated as a Special Ecological Area, in which faya is controlled.** This orchid is currently a candidate for propagation **and planting in protected wet forest SEAs of Nāhuku (Thurston Lava Tube) and the East Rift (Loh 2008a).** If successful, this project will restore the orchid to the park. If the species persists at unknown sites in the park, **reintroductions will increase the orchid's low numbers.** The potential impacts of slugs on this and other native ground-dwelling, soft-leaved species of HAVO are unknown and worthy of study.

REMARKS: This orchid may have been lost from all known park sites, including **`Ōla`a Forest, which was revisited in 2008. However, the orchid's small size and inconspicuous appearance make it easy to overlook, and there may be plants at unvisited sites in the dense forest of `Ōla`a.**

CULTURAL USES/ETHNOBOTANY: None known. The flowers are not showy enough to interest most orchid cultivators.



Hilo ischaemum, *Ischaemum byrone*
 Photos: Thomas Belfield, PCSU/NPS, HAVO

COMMON NAME: **Hilo ischaemum**

SCIENTIFIC NAME: *Ischaemum byrone*

FAMILY: Poaceae (Grass Family)

SYNONYMS: *Spodiopogon byronis*, *Andropogon byronis*, *Ischaemum lutescens*

FEDERAL AND STATE STATUS: Endangered Species, listed in 1994

DESCRIPTION: Perennial grass, 40–80 cm tall, spreading by means of stolons or runners. Leaf blade flat, 7–20 cm long and 3–5 mm wide, with a tip tapered to a point; ligule membranous, to 3 mm long, conspicuous. Inflorescence composed of two yellowish, digitately arranged racemes, 4–10 cm long; spikelets 6–7 mm long, hairy at base, with awns up to 26 mm long and tightly twisted. Fruit is a grain, golden in color, 3 mm long (Wagner *et al.* 1999). Phenology: Inflorescences may be seen throughout the year.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Windward shores of Moloka`i, Maui, and Hawai`i from the coast to 75 m (250 ft) elevation (Wagner *et al.* 1999). On Hawai`i Island the grass occurs at scattered sites from Hilo south along the coast of Puna District to the park. There are isolated occurrences of the grass in Kohala and at Rainbow Falls on the Wailuku River (Hitchcock 1974).

HAVO DISTRIBUTION: Rocky coastlines in the **park's eastern lowlands; from a site west of Kamoamoa** (destroyed) to Lae `Apuki. Also planted near Lae `Apuki, Kealakomo makai, Kahue, and Ka`aha and **persisting at Hōlei Sea Arch** near Lae `Apuki.

HABITAT: Rocky cliffs near the ocean, rooted in cracks within the pāhoehoe surface and on tumuli. On other islands, the grass grows among lava boulders near the sea.

SIMILAR SPECIES: There are no closely related species in Hawai`i; *Ischaemum byrone* is in the same tribe as the indigenous pili (*Heteropogon contortus*) and pilipili`ula (*Chrysopogon aciculatus*). Pili is a much taller bunchgrass, and it has a distinctive inflorescence with long, black, twisted awns. Pilipili`ula is stoloniferous like Hilo ischaemum, but it has very short, broad leaf blades, and an open panicle inflorescence with small spikelets. Several species of crabgrass (*Digitaria* spp.) grow in the same habitat near the sea cliffs of HAVO, and these grasses have a creeping life form similar to that of *Ischaemum byrone*. **The most common of these is Henry's crabgrass (*D. ciliaris*)** which may be distinguished from Hilo ischaemum by its subdigitate inflorescence of up to 12 racemes, each with a three-sided, winged axis on which the awnless spikelets are borne.

THREATS: Lava flows are currently a threat to this rare grass in HAVO; the largest known park population of 150–200 Hilo ischaemum plants was covered by lava in 1993. Feral goats may have threatened the grass in the past. Competition with alien grasses may be a problem for the species.

MANAGEMENT/RESTORATION STRATEGIES: The HAVO coastal lowlands are free of feral goats, and the alien fountain grass and select other invaders are controlled. Seeds and plants of Hilo ischaemum were salvaged from the largest park population before it was destroyed by lava; the progeny of these have been planted at four coastal sites, including Lae `Apuki **near Hōlei Sea Arch**, Kealakomo, Kahue, and Ka`aha. Survival of plantings was poor (<1%), and the grass has disappeared from all but the easternmost planting site (Belfield *et al.* 2011).

REMARKS: The nearest population outside the park is at **Kēōkea, just east of Kalapana**. This population may be useful as a source of seeds for future park restoration projects.

CULTURAL USES/ETHNOBOTANY: None known.

Table 6. Rare Plant Communities of Hawai`i Volcanoes National Park

Common Name (Scientific Name)	Global Rank*
Coastal Communities (near sea level)	
Anchialine Pool Communities (Low Salinity Lava Anchialine Pools)	G1
Lowland Communities (0–1,000 m, 0–3,280 ft elevation)	
`Ōhai Lowland Dry Shrubland (<i>Sesbania tomentosa</i> Lowland Dry Shrubland)	G1
Lama/`Ōhi`a lehua Lowland Mesic Forest (<i>Diospyros sandwicensis</i> / <i>Metrosideros polymorpha</i> Lowland Mesic Forest)	G3, Rare in HAVO
Montane Communities (>1,000–2,000 m, >2,380–6,560 ft elevation)	
Koa/Māmane Montane Dry Forest (<i>Acacia koa</i> / <i>Sophora chrysophylla</i> Montane Dry Forest)	G1
Koa/`Ōhi`a lehua/Mānele Montane Mesic Forest (<i>Acacia koa</i> / <i>Metrosideros polymorpha</i> / <i>Sapindus saponaria</i> Montane Mesic Forest)	G1
Subalpine Communities (>2,000–3,000 m, >6,560–9,849 ft elevation)	
Native Bunchgrass Subalpine Mesic Grassland (<i>Deschampsia nubigena</i> Subalpine Mesic Grassland)	G2
Multi-Zone Communities	
Fumarole Communities	GU

*Global Rank in Hawai`i Heritage Program (1987, 2002) Natural Community Classification

G1 is critically imperiled globally with 1–5 occurrences;

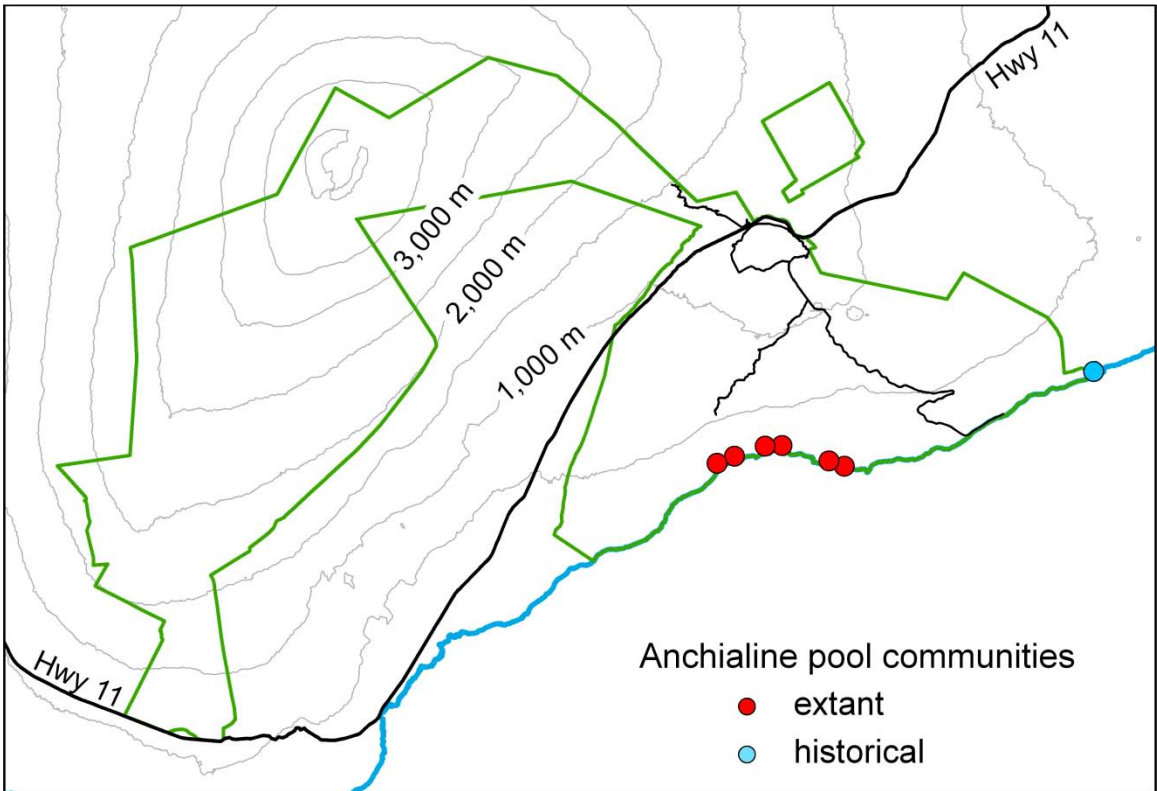
G2 is imperiled globally with 6–20 occurrences;

G3 is very rare and local or restricted range with 21–100 occurrences;

G4 is apparently secure globally with >100 occurrences;

GU is status uncertain, more information needed.

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Anchialine Pool Community
Photo: Linda Pratt, USGS, PIERC

COMMUNITY COMMON NAME: **Anchialine Pool Communities**

COMMUNITY SCIENTIFIC NAME: Low Salinity Lava Anchialine Pools

FEDERAL AND STATE STATUS: None

HAWAII HERITAGE PROGRAM GLOBAL RANK: G1, critically imperiled globally

DESCRIPTION: Anchialine pools are ponds near the coast on young, porous lava that are exposed portions of the groundwater table and have no direct surface connection to the ocean. These ponds have tidal fluctuations and brackish water, and they support a unique biota. Shallow pools often have orange-colored algal crusts (composed of blue-green algae such as *Schizothrix* and *Lyngbya*) covering rock surfaces. Larger pools may have riparian vegetation of native sedges, such as makaloa and *Cyperus polystachyos*. Pools showing signs of aging have surrounding vegetation of trees and shrubs, including natives and aliens. Senescence occurs when leaf litter falls into pools, accumulates over years, and eventually reduces pool size or completely fills the pond, converting it into a marsh. Milo and naupaka kahakai are native species commonly found near anchialine pools. Coconut palm or niu, a Polynesian introduction, grows or has been planted near several anchialine pools. Alien shrubs, particularly sourbush, surround pools at several sites. Near shore, shallow pools are usually sparsely surrounded with native vegetation, including `akulikuli and the sedge mau`u`aki`aki. Characteristic native fauna of the **park's anchialine pools include the crustaceans `ōpae`ula**; the scavenging anchialine pool shrimp, a predaceous red shrimp that is a candidate endangered species; `ōpae huna, a transparent/spotted shrimp; a brown prawn called `ōpae kala`ole; and a grapsid crab. The alien Tahitian prawn occurs in several HAVO pools. Native fish found in the anchialine pools of HAVO include `o`opu or gobies, as well as small individuals of a number of marine fishes: papio, āholehole, kūpīpī, **and** manini (Chai *et al.* 1989).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Maui and Hawai`i Island on geologically recent substrates near the ocean.

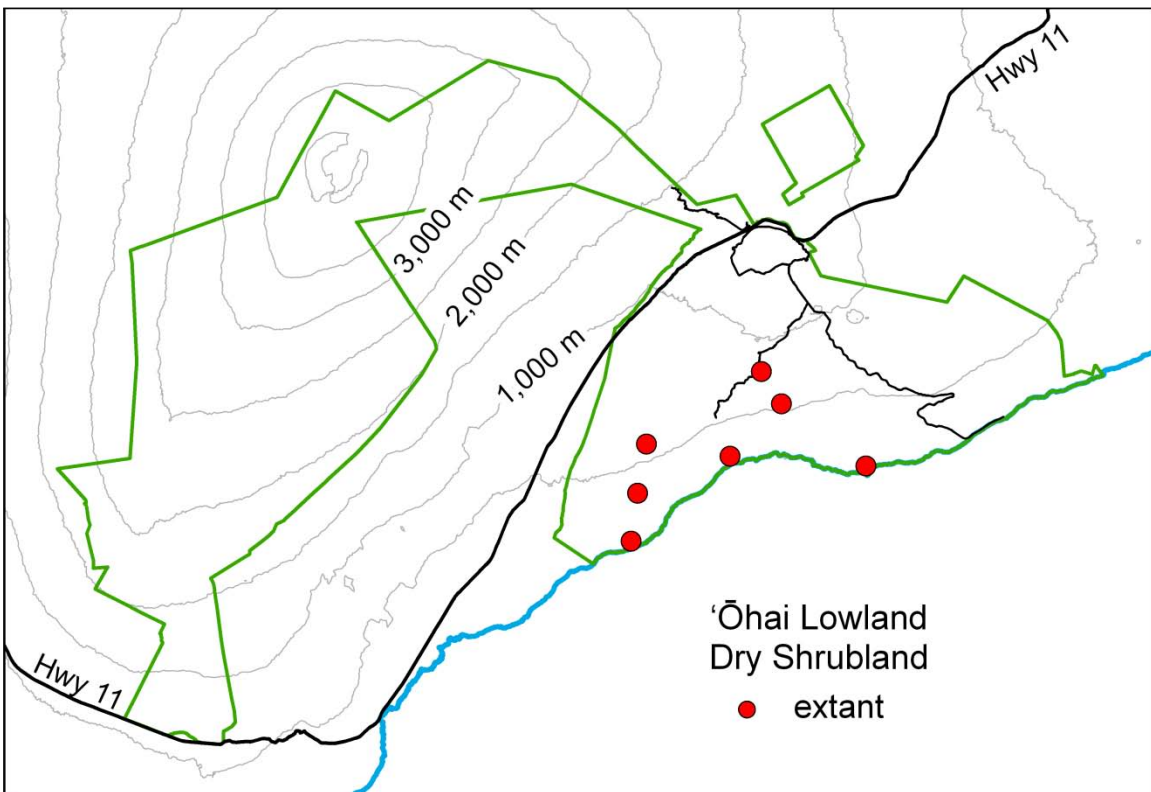
HAVO LOCALITIES/EXAMPLE: West of `Āpua Point, east of Keauhou (large complex), Halapē within a large crack or fault system, inland of the bay west of Halapē, Kālu`e, Ka`aha (the latter two in cracks), and formerly near Waha`ula. Halapē is perhaps the best known and most accessible of the park's anchialine pools.

RARITY WITHIN HAVO: Anchialine pools occur at fewer than 10 sites in HAVO.

THREATS: Alien predaceous crustaceans, such as the Tahitian prawn, prey on native crustaceans of the pools. Accessible pools are threatened by pollution from soaps, detergents, and other chemicals used by visitors. Leaf litter from alien vegetation, particularly sourbush, may hasten the eutrophication and sedimentation/filling of anchialine pools. At least one pool along the eastern coast of HAVO has been **covered by lava from the ongoing eruption of Pu`u `Ō`ō.**

MANAGEMENT STRATEGIES: Visitors to Halapē **and other coastal sites supporting pools are reminded to** avoid using soaps when bathing in anchialine pools. The presence of alien crustacean species may impact native pool fauna, but removal would be difficult. Future introduction of non-native fish is unlikely because of the remote location of HAVO pools, but could be discouraged by visitor education and interpretation. Encroaching vegetation leads to sedimentation and eventual filling of pools, but this process is natural where surrounding plants are native. Some invasive alien plants, such as kiawe have been removed from the perimeters of anchialine pools in HAVO (Tunison *et al.* 1992).

REMARKS: Anchialine pools of HAVO typically are of low salinity and do not support the high native species diversity displayed by pool systems of the Kona coast. Park pools were briefly surveyed for animals and some physical parameters in the late 1980s (Chai *et al.* 1989).



'Ōhai Lowland Dry Shrubland, *Sesbania tomentosa* Lowland Dry Shrubland
Photo: Linda Pratt, USGS, PIERC

COMMUNITY COMMON NAME: **`Ōhai Lowland Dry Shrubland**

COMMUNITY SCIENTIFIC NAME: *Sesbania tomentosa* Lowland Dry Shrubland

FEDERAL AND STATE STATUS: None

HAWAII HERITAGE PROGRAM GLOBAL RANK: G1, critically imperiled globally

DESCRIPTION: This shrubland community occurs at several sites in the dry central and western HAVO **lowlands between sea level and 850 m (2,800 ft) elevation, usually on pāhoehoe and shallow ash substrates.** Shrub cover is relatively sparse and low but is almost entirely composed of the endangered **`ōhai. Grasses, both native and alien, have high cover in this community. The indigenous pili is often present,** as are the aliens Natal red-top, molasses grass, bush beardgrass, and African thatching grass. The low-growing native shrub *uhaloa* is ubiquitous in dry shrublands, as are the alien herbs Japanese tea and three-flowered beggarweed. At the upper elevational range of the community, scattered native **`ōhi`a lehua and māmane trees and shrubs such as pūkiawe and `a`ali`i occur within the community. At `Āpua Point, the `ōhai shrubland reaches the coast, and the rare shrub grows with coconut trees, the native coastal shrubs naupaka kahakai and `ilima, the native vines nanea, pōhuehue, and pa`ū o Hi`iaka, and the coastal sedge mau`u`aki`aki.**

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawaii`i and Moloka`i, perhaps formerly on other islands. The coastal version of the shrubland is relictual on all the main Hawaiian Islands except Ni`ihau and Lāna`i.

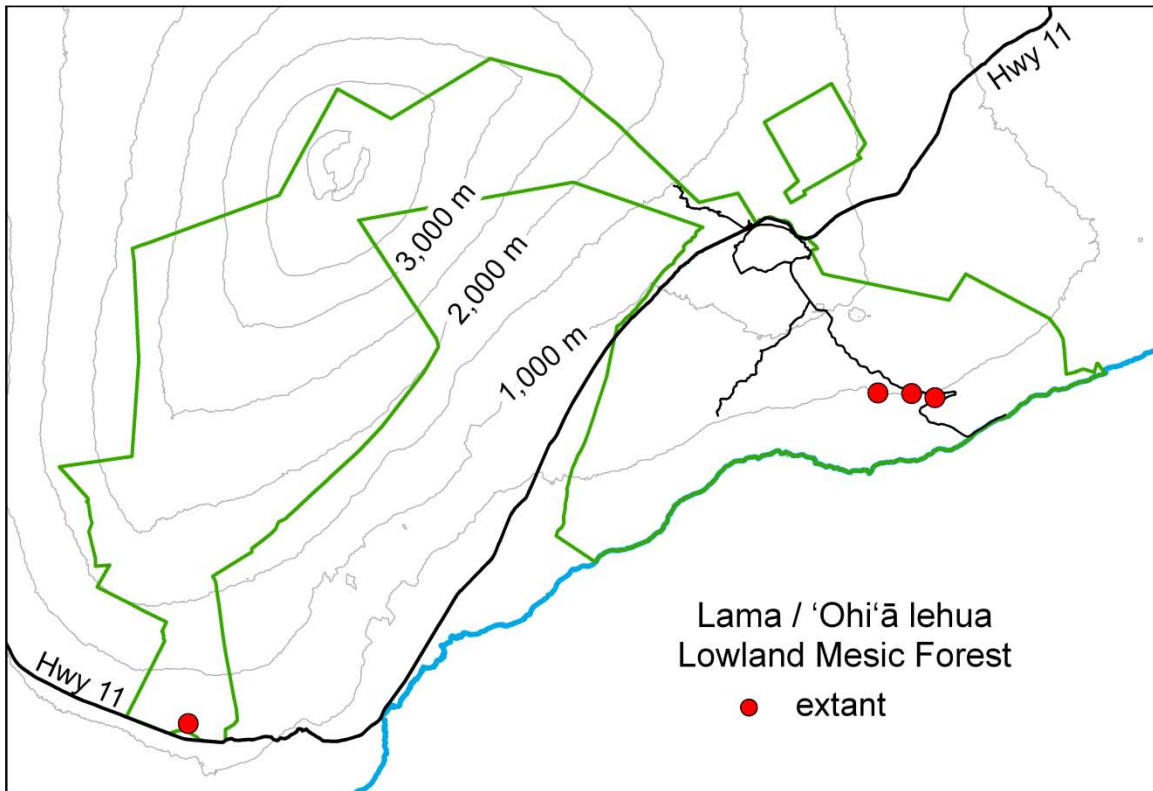
HAVO LOCALITIES/EXAMPLE: **Kamo`oali`i and Pepeiau have the largest expanse of `ōhai shrubland, which also occurs in remote sites at Kū`ē`ē and kīpuka near Hilina Pali. Kīpuka Nēnē supports an accessible example of the community, although it has been degraded by fire and is somewhat atypical (this is near the upper limit of `ōhai distribution). `Āpua Point is accessible along the Puna/Ka`ū coastal trail, approximately 9 km (6 miles) from the nearest road.**

RARITY WITHIN HAVO: Rare with fewer than 10 occurrences within the park.

THREATS: Alien grasses and wildfire are the greatest current threats to this dry community, which was formerly disturbed by feral goats prior to their removal in the 1970s (Baker and Reeser 1972). Rats are **seed predators of `ōhai (Hopper 2002, Pratt *et al.* 2011).**

MANAGEMENT STRATEGIES: Prevention of fire is critical to the preservation of this community in HAVO, and fires are suppressed throughout the park lowlands. Reduction of alien grasses and rats would probably encourage reproduction **of the dominant `ōhai shrub, but neither large-scale control of rats or alien grasses has been tested or studied for feasibility.**

REMARKS: The examples of this shrubland remaining in HAVO and elsewhere are likely relicts of a once-widespread lowland plant community (Wagner *et al.* 1999).



Lama / 'Ohi'a lehua Lowland Mesic Forest, *Diospyros sandwicensis* / *Metrosideros polymorpha* Lowland Mesic Forest
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMUNITY COMMON NAME: **Lama/`Ōhi`a lehua Lowland Mesic Forest**

COMMUNITY SCIENTIFIC NAME: *Diospyros sandwicensis*/*Metrosideros polymorpha* Lowland Mesic Forest

FEDERAL AND STATE STATUS: None

HAWAII HERITAGE PROGRAM GLOBAL RANK: G3, very rare and restricted range (Rare in HAVO)

DESCRIPTION: This dry to mesic forest dominated by lama and `ōhi`a lehua occurs in kīpuka on both `ā`a and pāhoehoe substrates below 460 m (1,500 ft) elevation in the eastern lowlands of the park. The canopy may be open or closed, with denser tree cover growing in wetter sites that also support kukui, a Polynesian introduction. The native species diversity is high in this forest, which contains rare tree species such as `ahakea, hao, `ohe makai, maua, and the endangered hala pepe. Māmane and naio grow on the dry upper forest edges. The native shrub `a`ali`i is abundant in the area and has increased in cover due to recurring fires nearby. Alahe`e is a common understory tree and `iliahi, or sandalwood, is less common. There was probably little ground cover in the undisturbed forest other than a few native ferns and herbs, such as `ala`ala`wainui and spurflower. Today ground cover is dominated by alien Asian swordfern and lantana in shady areas and invasive non-native grasses in sunny, exposed sites.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: All main Hawaiian Islands except Ni`ihau and Kaho`olawe (Gagné and Cuddihy 1999).

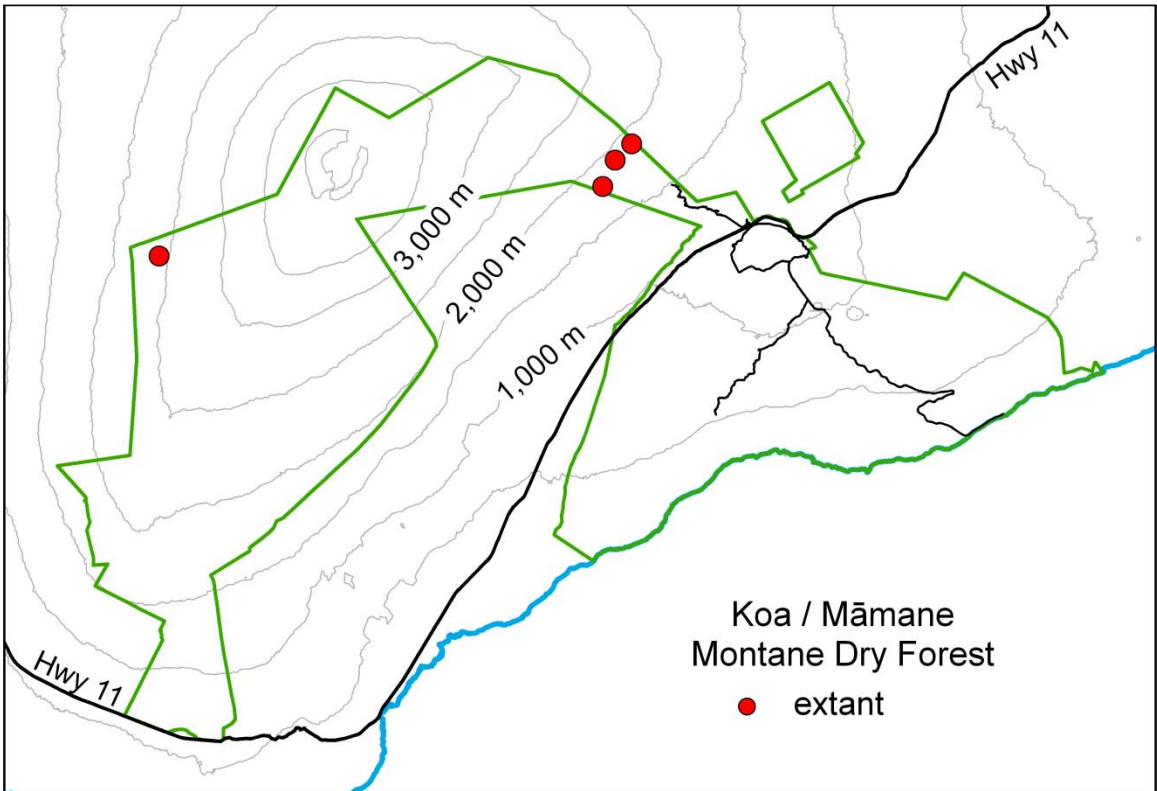
HAVO LOCALITIES/EXAMPLE: Nāulu Forest kīpuka and Kealakomo kīpuka; another unnamed kīpuka to the west supports a somewhat less diverse forest. A dry and less diverse version of this forest is found in Kahuku Unit east of Hawai`i Ocean View Estates and the 1887 lava flow, just north of Highway 11.

RARITY WITHIN HAVO: Few relictual examples of this forest remain in HAVO, since lava flows from Mauna Ulu covered much of this area in 1969–74 (Holcomb 1987). This forest type formerly extended upslope and to the east of existing remnants.

THREATS: Feral goats damaged this forest and interfered with woody plant reproduction when they were present. Alien rats may be impacting tree reproduction through seed predation. Alien plants that have invaded the forest compete with natives and increase the likelihood of damaging wildfire; those with high cover include lantana, Asian swordfern, and alien grasses, most commonly bush beardgrass, molasses grass, and Natal red-top. Sulfur dioxide fumes from the ongoing eruption have negatively impacted some of the tree species that are components of this forest, and the fragmentation of the **forests by recent lava flows has reduced the area covered by this vegetation type to small kīpuka subject to drying winds.**

MANAGEMENT STRATEGIES: Feral goats were removed from the coastal lowlands in the 1970s (Baker and Reeser 1972). Recently, a HAVO Natural Resource Management invasive plant control project **cleared lantana, swordfern, and alien grasses from sections of Nāulu Forest**, and a number of native tree and shrub species were restored to the kīpuka or were planted to augment existing populations (Belfield *et al.* 2011). Reduction or control of seed-predating rats has not yet been attempted on the landscape scale.

REMARKS: Restoration to Nāulu Forest and Kealakomo of many missing or depleted rare trees and shrubs began in 2001.



Koa/Māmane Montane Dry Forest, *Acacia koa/Sophora chrysophylla* Montane Dry Forest
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMUNITY COMMON NAME: **Koa/Māmane Montane Dry Forest**

COMMUNITY SCIENTIFIC NAME: *Acacia koa/Sophora chrysophylla* Montane Dry Forest

FEDERAL AND STATE STATUS: None

HAWAII`I HERITAGE PROGRAM GLOBAL RANK: G1, critically imperiled globally

DESCRIPTION: This forest, in which māmane is the co-dominant tree species, is the upper-elevation example of the more common montane koa forest that dominates older substrates along the Mauna Loa Road. The canopy is open and native shrubs are prominent in the understory, particularly, tall `a`ali`i, pūkiawe, and `ōhelo. **In a few kīpuka, naio, `iliahi, and kōlea lau nui are also components of the forest.**

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i Island on Mauna Loa, Mauna Kea, and Hualālai (Gagné and Cuddihy 1999).

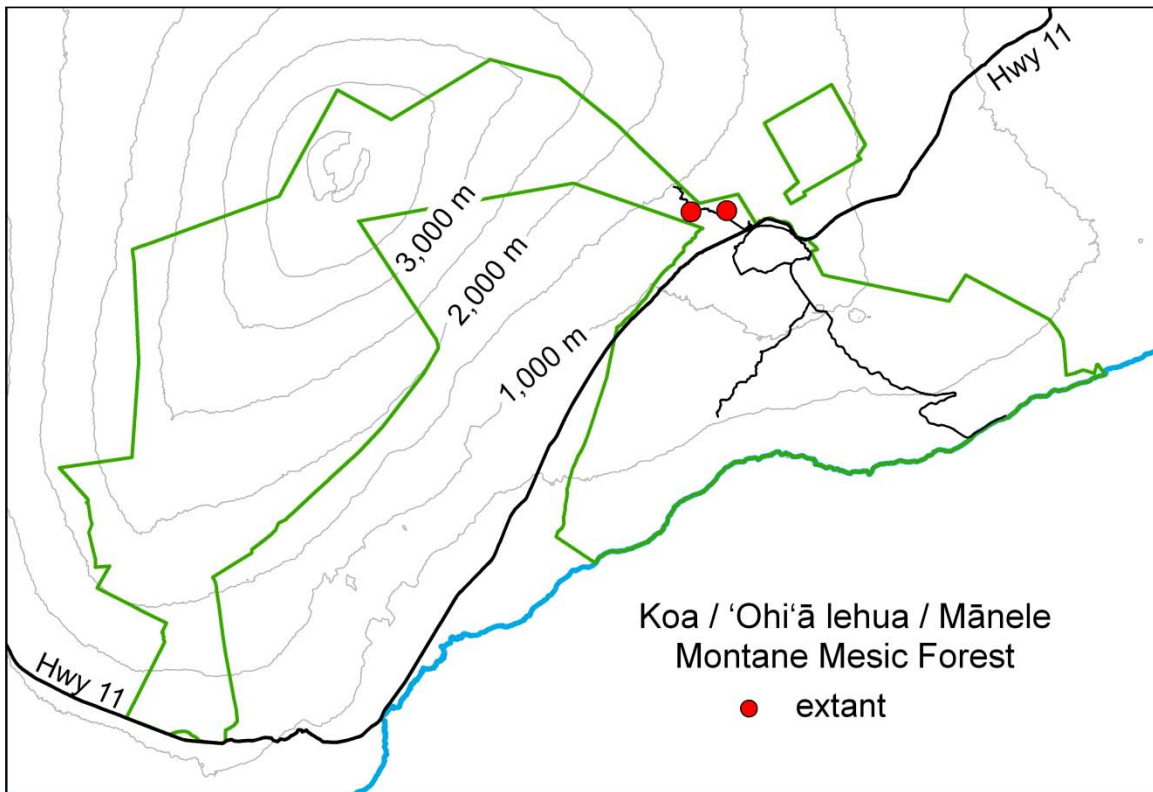
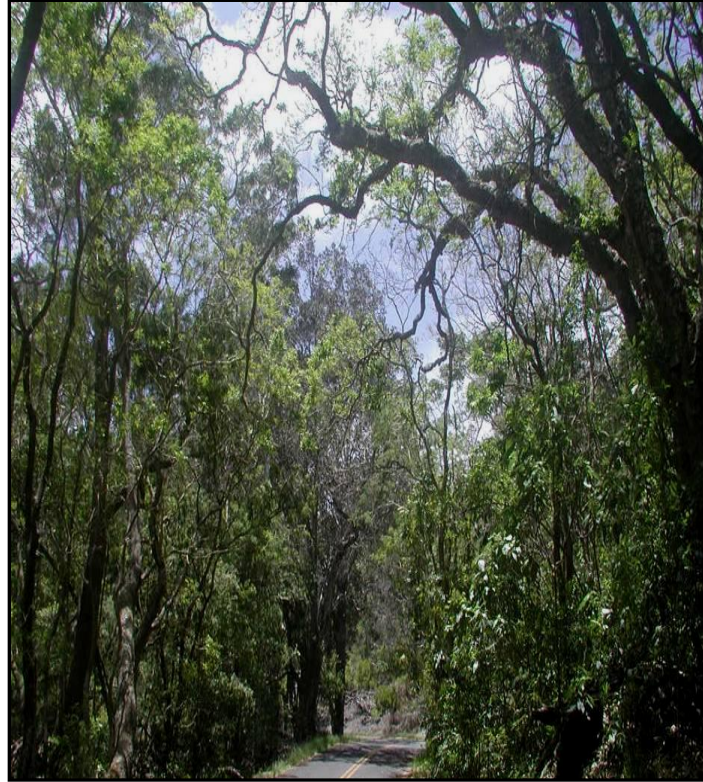
HAVO LOCALITIES/EXAMPLE: Kīpuka Kulalio and Kīpuka Mauna`iu of the Mauna Loa Strip and several small kīpuka near the Kapāpala Ranch boundary fence; the Kīpuka Kulalio example is accessible near the top of the Mauna Loa Road.

RARITY WITHIN HAVO: In HAVO, this vegetation type is restricted to the upper reaches of two large **kīpuka in the Mauna Loa Strip** and within the Kahuku Unit in a remote area on the western slope of Mauna Loa.

THREATS: This montane forest was formerly impacted by feral goats, which stripped the bark of **māmane trees and prevented reproduction of both māmane and koa**. Mouflon sheep are a potential threat to the integrity of this forest.

MANAGEMENT STRATEGIES: The HAVO examples of this forest are protected within the Powerline exclosure and the new alpine unit of the Mauna Loa Special Ecological Area. Domestic cattle were removed in the 1940s and feral goats and pigs were eradicated from the Powerline unit in the 1980s (Katahira *et al.* 1993). Mouflon sheep are excluded by park boundary fences. **Māmane has increased** greatly with protection from ungulates, and the forest has many young trees and saplings. Efforts were **recently made to restore missing and depleted native plants, such as `ōhelo papa or strawberry and** rare mints (stachys-like Hawaiian mint, narrow-leaved Hawaiian mint) (Belfield *et al.* 2011). No management activities have been focused on this community at Kahuku, although mouflon sheep are being reduced throughout the unit.

REMARKS: This rare community is extensive, although not continuous, within an elevational band above 1,800 m (6,000 ft) on the Mauna Loa Strip. It is now protected and appears to be secure within HAVO.



Koa / 'Ohi'a lehua / Mānele Montane Mesic Forest, *Acacia koa* / *Metrosideros polymorpha* / *Sapindus saponaria* Montane Mesic Forest
Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMUNITY COMMON NAME: **Koa/`Ōhi`a lehua/Mānele Montane Mesic Forest**

COMMUNITY SCIENTIFIC NAME: *Acacia koa*/*Metrosideros polymorpha*/*Sapindus saponaria* Montane Mesic Forest

FEDERAL AND STATE STATUS: None

HAWAII HERITAGE PROGRAM GLOBAL RANK: G1, critically imperiled globally

DESCRIPTION: One of the most botanically diverse forest communities of HAVO, this mesic forest is **restricted to ancient kīpuka with deep ash soil. This rare community has as its canopy dominants koa and mānele, with scattered tall emergent `ōhi`a lehua, particularly on the edges of the kīpuka and in rocky intrusions of more recent lava at Kīpuka Kī. Mānele is one of few native deciduous trees; every winter or spring leaves turn yellow and drop and are immediately followed by fresh green foliage. The dense forest understory is composed of a suite of common and uncommon native trees, most notably pilo, kōlea lau nui, pāpala kēpau, olopua, and māmaki. Ground cover is sparse where shade is deep, but native herbs (e.g., `ala`ala wai nui, and others) and ferns are common in areas with partial shade. Ferns most often encountered are palapalai, laukāhi, `i`i, kupukupu or swordferns, and Cretan brake fern. Rare elements here include the endangered Zahlbruckner's alani and Giffard's hau kuahiwi, the candidate threatened/endangered large-leaved `ānunu, and species of concern manena and kāwa`u.**

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Hawai`i Island only, intact examples are restricted to HAVO (Gagné and Cuddihy 1999). Outside HAVO, there are remnants of this forest in the adjacent Kapāpala Ranch and at Pu`uwa`awa`a on the leeward side of Hawai`i Island.

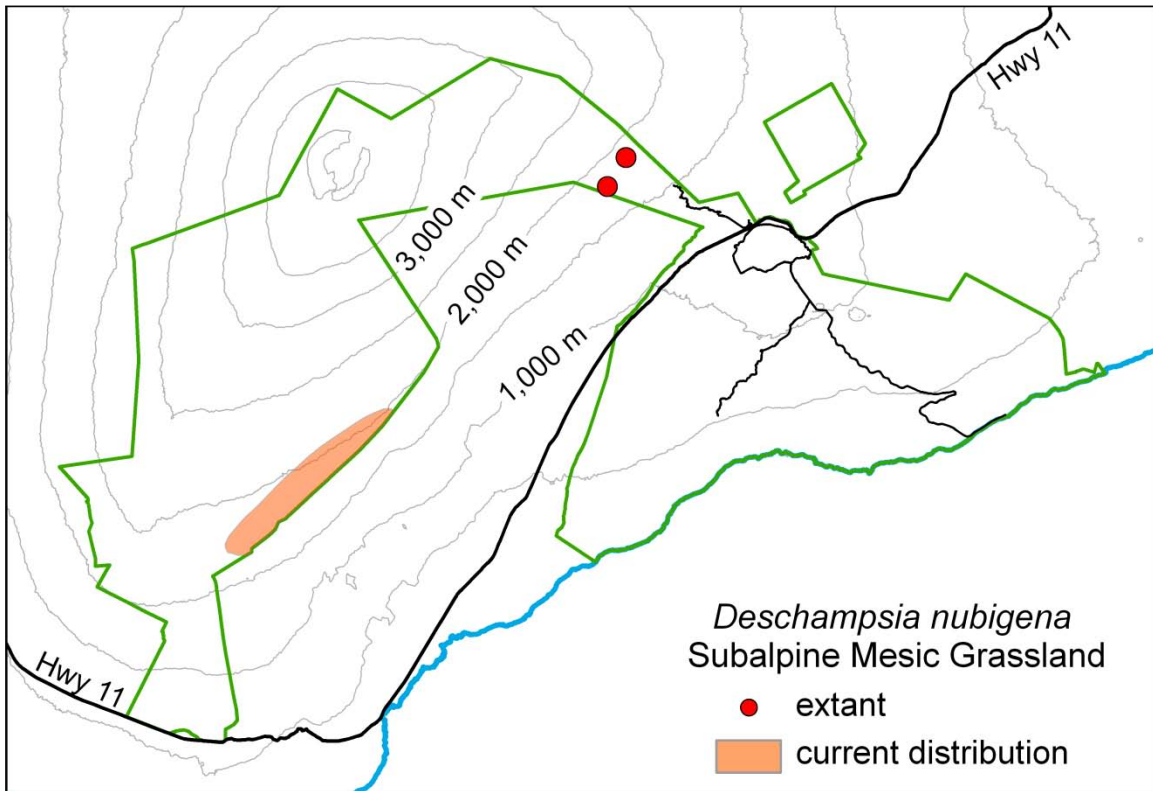
HAVO LOCALITIES/EXAMPLE: Kīpuka Puaulu and Kīpuka Kī, on the lower part of the Mauna Loa Road. Kīpuka Puaulu is highly accessible with a 1.6-km-long loop trail that begins at the Mauna Loa Road approximately 2 km from Highway 11.

RARITY WITHIN HAVO: This community type is restricted to two **kīpuka within the park.**

THREATS: **Both kīpuka were formerly grazed by cattle** and have been damaged by feral goats and pigs in the past. Both are now protected within ungulate-free units. Despite great progress with alien plant control in both kīpuka, **prickly blackberry, Jerusalem cherry, strawberry guava, kāhili ginger, and alien grasses (primarily meadow ricegrass) continue to require treatment for their control in the two kīpuka.**

MANAGEMENT STRATEGIES: Kīpuka Puaulu was fenced to exclude cattle in the 1930s, and a pig-proof fence was in place by the 1960s. Cattle continued to graze in Kīpuka Kī and the Mauna Loa Strip until they were removed in 1948 (Apple 1954). Goats were controlled in the 1970s (Baker and Reeser 1972), and feral pigs were removed from the Kīpuka Kī unit in 1983–85 (Katahira *et al.* 1993). Both kīpuka have been considered Special Ecological Areas since the 1980s. Cessation of cattle grazing and feral ungulate removal were important first steps in managing the kīpuka. Since the early 1980s the most invasive alien plant species have been targeted for control in both kīpuka (Tunison and Stone 1992). More than 20 rare and endangered species of shrubs and trees have been restored to this mesic forest community in HAVO (Belfield *et al.* 2011), resulting in successful re-introduction of missing species and augmentation of species depleted by past land use practices.

REMARKS: Kīpuka Puaulu is a jewel among the park's natural areas.



Native Bunchgrass Subalpine Mesic Grassland, *Deschampsia nubigena* Subalpine Mesic Grassland

Photo: Thomas Belfield, PCSU/NPS, HAVO

COMMUNITY COMMON NAME: **Native Bunchgrass Subalpine Mesic Grassland**

COMMUNITY SCIENTIFIC NAME: *Deschampsia nubigena* Subalpine Mesic Grassland

FEDERAL AND STATE STATUS: None

HAWAII HERITAGE PROGRAM GLOBAL RANK: G2, imperiled globally

DESCRIPTION: Dominated by the tall endemic bunchgrass *Deschampsia nubigena*, this is a relatively species-**poor community that has developed on shallow ash soils over pāhoehoe lava. Other native** grasses and sedges that may be present are mountain pili, *Carex wahuensis*, and *Morelotia gahniiformis*. Native bracken fern is the most common fern in this community, although indigenous species of **spleenwort (`oāli`i and `iwa`iwa) and kalamoho lau li`i may be present on rocky out-croppings.** Native shrubs, such as **pūkiawe and `ōhelo, are usually present and achieve greater cover on rocky sites.** Alien grasses and the herbaceous gosmore are typical, particularly where cattle or feral ungulates have impacted the grassland.

DISTRIBUTION IN THE HAWAIIAN ISLANDS: East Maui near 2,100 m elevation (6,900 ft) and Hawai`i Island on Mauna Loa at 1,680–1,980 m (5,510–6,500 ft) elevation (Gagné and Cuddihy 1999).

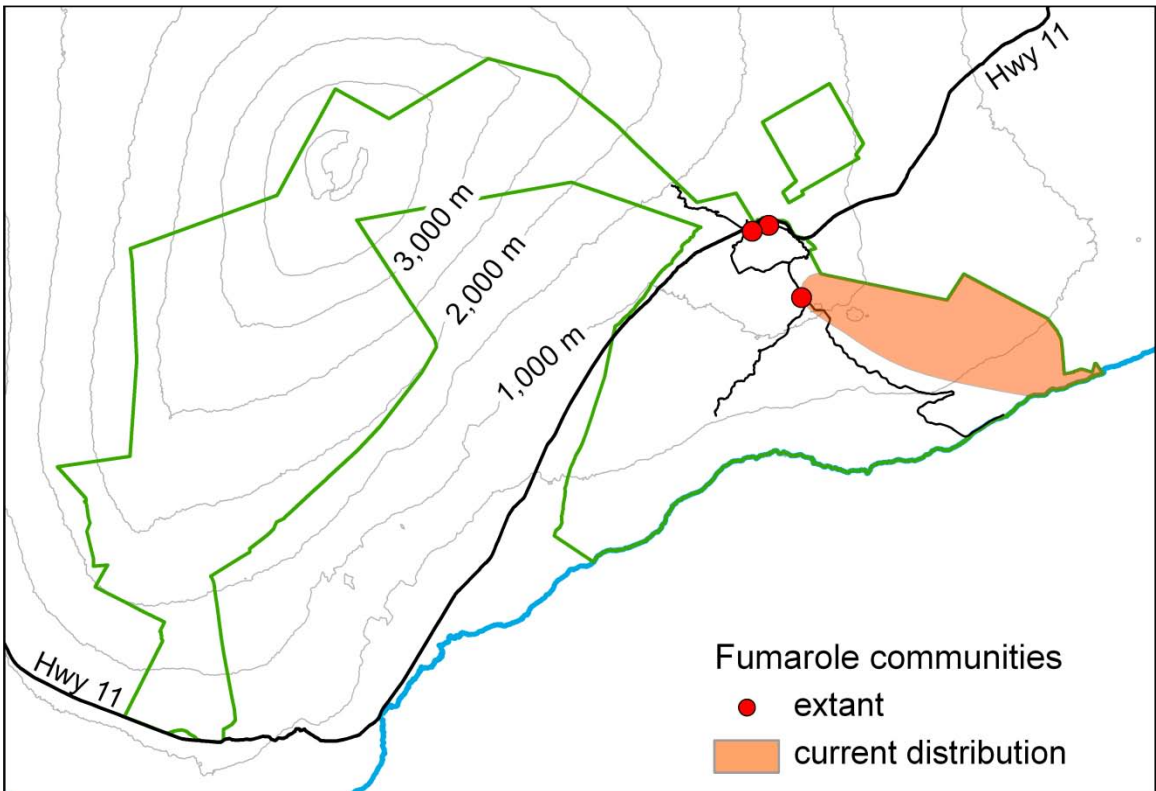
HAVO LOCALITIES/EXAMPLE: This grassland occurs as relatively small patches within koa forest of the Mauna Loa Strip; larger expanses of this grassland are found at Kahuku Unit along the road traversing **the eastern slope above Ka`ū Forest Reserve. Accessible examples are found near the top of the Mauna Loa Road.**

RARITY WITHIN HAVO: Relatively rare on the Mauna Loa Strip; larger areas of this community occur at Kahuku Unit.

THREATS: Feral pigs, goats, and mouflon sheep have damaged this community in the past and are still present at Kahuku Unit. Alien grasses, such as velvet grass and sweet vernal grass, have invaded native montane and subalpine grasslands.

MANAGEMENT STRATEGIES: This grassland has shown resilience and ability to recover, and has persisted even after long-term damage by cattle and feral ungulates. Removal of feral ungulates was a first step toward protection of the grassland in the Mauna Loa Strip of HAVO. Mouflon sheep numbers are being reduced at Kahuku Unit. Jacobi (1981) found that alien grasses persisted in *Deschampsia* grassland on Maui even after fencing and protection from feral ungulates. Large-scale removal of alien grasses has not been attempted within HAVO, and feasibility of such an effort is uncertain and unstudied.

REMARKS: This grassland community is best developed on the upper windward slopes of East Maui (Gagné and Cuddihy 1999). HAVO examples occur in somewhat drier sites and extend down slope into the montane zone.



Fumarole Communities
Photos: Linda Pratt, USGS, PIERC

COMMUNITY COMMON NAME: **Fumarole Communities**

COMMUNITY SCIENTIFIC NAME: Fumarole Communities

FEDERAL AND STATE STATUS: None

HAWAII HERITAGE PROGRAM GLOBAL RANK: GU, status uncertain

DESCRIPTION: The immediate areas around steam vents in the Kīlauea summit area are typically dominated by native ferns, particularly uluhe, kupukupu, and wāwae`iole. A few meters from steam vents native trees of the adjacent forest such as `ōhi`a lehua are common; close to the vents these trees may be somewhat stunted in size. At a site near the Chain of Craters Road, there are concentrations of steam vents in a large geothermal area, which is sparsely vegetated and very fragile. The only trees present are `ōhi`a lehua that are epiphytic on old stumps. Grasses surround the geothermal area, but have a difficult time establishing within the core area because of the heat of the substrate. The sparse vegetation is composed primarily of native sedges (*Fimbristylis dichotoma*, *Cyperus polystachyos*), the shrub `uhaloa, and two `ihi species, one native and endangered (`ihi mākole) and the other a relatively recent alien invader. Fragile crusts of native mosses and lichens are prominent on the edge of the geothermal area near steam vents (Smith 1981).

DISTRIBUTION IN THE HAWAIIAN ISLANDS: Restricted to geologically active regions of Hawai`i Island.

HAVO LOCALITIES/EXAMPLE: The steam vents area on the Crater Rim Drive and vents of the Sulphur Banks area are the most accessible fumarole communities in HAVO. Fumaroles are also found on recent substrates along the upper Chain of Craters Road and throughout **the East Rift of Kīlauea Volcano.**

RARITY WITHIN HAVO: While individual steam vents are numerous, they are concentrated at few sites.

THREATS: Vegetation and moss/lichen crusts near steam vents are sensitive to trampling by humans. Alien grasses and trees, such as faya and strawberry guava, encroach on steam vents at several sites.

MANAGEMENT STRATEGIES: Visitation is discouraged at the large geothermal area near Puhimau Crater, **which is important as a site supporting the endangered `ihi mākole and** may be damaged by increased human impacts. Maps to the geological site have been deleted from a popular guide to geological features of the park (Hazlett 1987). **Fumaroles near Kīlauea Caldera are in areas free of feral ungulates,** and highly invasive plants such as faya are controlled where possible. Visitors are channeled on marked **trails near Kīlauea summit fumaroles. The East Rift Special Ecological Area, which contains many** fumaroles, has been fenced and feral pigs are controlled.

REMARKS: Steam vents are culturally important to many Hawaiians.

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Glossary

(Plant definitions follow those of Harris and Harris 2001 or Wagner *et al.* 1999.)

- achene:** A small, dry, indehiscent fruit with a single seed.
- acuminate:** Gradually tapering to a sharp point with concave sides; used to describe leaf tips.
- acute:** Tapering to a point with straight side; used to describe leaf tips.
- aggregate:** A cluster of small fleshy fruits originating from separate pistils in a single flower.
- alternate:** Borne singly at each node, used for leaf placement on stems.
- anthers:** The section of the stamen or male part of the flower containing pollen.
- antrorse:** Directed forward or upward.
- apex:** The tip or point farthest from the point of attachment.
- appressed:** Pressed flat, used for hairs pressed close to the leaf blade.
- aril:** A fleshy appendage of a seed.
- asymmetrical:** Irregular in shape.
- awl-shaped:** Short, narrowly triangular, and sharply pointed.
- awn:** A narrow, bristle-like appendage; often seen in grass flowers.
- axillary:** Positioned in an **axil**, the angle between a stem and leaf.
- berry:** A fleshy fruit with many seeds.
- bipinnately compound:** Twice pinnate (divided like a feather); for leaves this means the leaflets are also divided.
- blade:** The broad, usually flattened part of a leaf or flower petal.
- bract:** A reduced leaf-like structure at the base of flowers or inflorescences.
- bristle:** A short, stiff hair.
- bulbous:** Bulblike.
- callose:** Hardened or thickened.
- callose-crenulate:** Bearing small, rounded, thick teeth; used for leaf margins.
- calyx:** The outer whorl of petals or leaf-like structures that subtend a flower; collective term for the sepals.
- campanulate:** Bell-shaped
- capsule:** A dry, dehiscent fruit composed of more than one carpel.
- carapace:** The shell of a reptile.
- carpel:** A simple pistil or female part of a flower.
- cauline:** On a stem or relating to a stem.
- chelae:** Pincers in crustaceans.
- clawed:** Having a narrow base; used for petals and sepals.
- cleft:** Cut about halfway; used for leaf lobes.
- column:** A structure formed by the fusion of staminal filaments or the filaments and style (as in orchids).
- compound (leaf):** Separated into two or more leaflets.
- cordate:** Heart-shaped; used to describe leaf bases.
- coriaceous:** Having a leathery texture; used for leaves.
- corolla:** Collective name for the petals of a flower.
- crenate:** Having rounded teeth; used for leaf margins.
- crenulate:** Having very small rounded teeth.
- cuboid:** Shaped like a cube, with six almost square sides.
- cuneate:** Wedge-shaped and tapering to a point at the base; used for leaves.
- cyme:** A flat- or round-topped inflorescence in which the terminal flower blooms first.

deciduous: Falling off or not persistent; used for leaves.

dehiscent: Opening when ripe to release contents; used for dry fruits.

deltate: Shaped like an equilateral triangle or the Greek letter delta.

dentate: Toothed with the teeth pointing outward; used for leaf margins.

denticulate: Toothed with very small teeth.

digitate: Arranged like the fingers of a hand; lobed, divided, or veined from a common point.

dimorphic: Having two forms (e. g., male and female, adult and juvenile).

dioecious: Plants with unisexual flowers borne on separate plants.

disk: An enlargement of the receptacle at the base of the ovary of a flower.

disk floret: A small regular flower central in heads of Aster Family species.

domatia: Pits on the underside of leaves near the midrib.

dorsal: The back or outward surface of an organ.

drupe: A fleshy indehiscent fruit with a stony inner section and usually one seed.

drupelet: A small drupe, which is a fleshy indehiscent fruit with a stony inner section.

ellipsoid: Elliptic in long-section and circular in cross-section.

elliptic: In the shape of a narrow oval or ellipse, broadest at the middle.

emarginated: Notched at the apex; used for leaf tips.

endocarp: The inner layer of a fruit.

epiphytic (epiphyte): A plant growing on another plant, but not a parasite.

exocarp: The outer layer of a fruit.

exserted: Projecting beyond surrounding parts; as in stamens.

exuva(e): Larval skin in insects.

filament: The thread-like stalk of a stamen, the male part of a flower.

fissured: Bark texture characterized by long and narrow cracks.

foliaceous: Shaped and colored like a leaf, or bearing leaves.

follicle: A dry dehiscent fruit opening along a single side.

fusiform: Spindle-shaped, broadest at the middle.

glabrous: Smooth and hairless.

gland: A structure that secretes sticky or oily substances.

glandular-punctate: Dotted with glands.

globose: Spherical.

grain: A seed-like, dry, indehiscent fruit with one seed; characteristic of grasses.

gravid: Pregnant, carrying eggs.

head: A dense cluster of sessile flowers; characteristic of the Aster Family.

hemiparasite: A partial parasite that derives some nourishment from a host organism.

herb: A non-woody plant.

hirsute: Hairy with coarse, stiff hairs.

hypanthium: A cup-shaped extension of the flower axis formed from the union of the basal parts of the calyx, corolla, and stamens.

impressed: Below the surface; used for sunken leaf veins.

indehiscent: Not opening at maturity; used for fruits.

indusium: A thin outgrowth of the epidermis of a fern leaf that covers the sorus, or spore-bearing cluster.

inflorescence: A flower cluster.

infuscation: Darkening with a brownish shade.

keel: A prominent longitudinal ridge; also used for petals of flowers in the Pea Family.

keeled: Ridged like the keel of a boat.

labellum: A specialized central petal of an orchid flower.

lanceolate: Lance-shaped, longer than wide.

larva, larvae: The immature form of an insect with complete metamorphosis (between egg and pupa).

leaf blade: The flat, expanded part of a leaf.

legume: A dry dehiscent fruit opening along two lines; characteristic of the Pea Family.

lenticel: A raised, lens-shaped, corky spot on a stem.

lenticular: Lens-shaped with a dome top on both sides and thinner edges.

liana: A woody, climbing vine.

ligule: A membranous appendage at the junction of the leaf and leaf sheath of grasses.

linear: Long and narrow, with parallel sides.

lobe: A rounded division or segment; used for leaf shape.

mandible: Upper or lower part of a bird's beak.

midrib: The central vein of a leaf.

monocarpic: Flowering and bearing fruit only once, then dying.

mycorrhizae: A symbiotic relationship between a fungus and the root of a plant.

naiad: The immature or juvenile form of damselflies.

node: The position on a stem where leaves and branches originate.

nutlet: A small nut or dry indehiscent fruit with a single seed.

obconical: Cone-shaped with the attachment at the narrow end.

oblanceolate: Inversely lanceolate or lance-shaped with the attachment at the narrow end.

oblong: Two to four times longer than wide with nearly parallel sides; used for leaf shape.

obovate: Inversely ovate (egg-shaped) and attached at the narrow end.

obovoid: Inversely ovoid with the attachment at the narrow end.

obtuse: Rounded at the apex.

opposite: Borne across from each other at the same node; used for leaves.

ovary: The basal part of the pistil or female part of the flower.

ovate: Egg-shaped and attached at the broad end; used for leaf shape.

ovoid: Egg-shaped, three-dimensional.

palmately compound: Divided from a common point, with leaflets like the fingers of a hand.

palmately lobed: Lobed from a common point.

palmiform: Shaped like a palm tree with leaves at the tip of the stem.

panicle (paniculate): A branched inflorescence with flowers maturing from the bottom upward.

pappus: Modified calyx of a flower of the Aster Family consisting of awns, scales, or bristles attached to the apex of the fruit or achene.

pedicel: The stalk of a single flower in an inflorescence.

peduncle: The stalk of a single flower or an entire inflorescence.

perennial: A plant that lives three or more years.

perfect: Bisexual, bearing both male and female reproductive organs in a flower.

perianth: The calyx and corolla of a flower, collectively.

petal: An individual section of a flower corolla, often colored.

petiole: A leaf stalk.

pinna (pinnae): A leaflet or primary division of a leaf; used for ferns.

pinnately compound: A leaf with leaflets arranged in feather fashion.

pinnately divided: A leaf cut or lobed to the base or to the midrib in feather fashion.

pinnatifid: Pinnately lobed half the distance to the midrib.

pistillate: Bearing a pistil, the female part of a flower, but not stamens or male parts.

prefrontal: Between the eyes.

prickle: A sharp outgrowth of the epidermis, without vascular tissue.

proliferous: Bearing plantlets on fern stipes, rachises, blades, stolons, or roots.

pruinose, pruinosity: Covered with a waxy substance that reflects light and causes a silvery sheen.

pseudobulb: A bulbous thickening of the stem in some orchids.

pubescent (pubescence): Covered with short, soft hairs (hairiness).

quadripinnate: Four times pinnately compound.

raceme (racemose): An unbranched inflorescence with stalked flowers maturing from the bottom upwards.

rachis: The main axis of a leaf or inflorescence.

ray: A branch of an umbel (type of inflorescence) that bears a flower or flowers.

ray floret: A small flower bearing a petal-like ligule in a congested inflorescence or head; characteristic of the Aster Family (Asteraceae).

receptacle: The part of the pedicel or peduncle where the flower parts or flowers are borne.

recurved: Curved backward.

reflexed: Bent backward or downward.

reticulate: In the form of a network, net-veined.

rhizome: A horizontal, underground stem.

rhomboidal: Quadrangular or four-sided with obtuse lateral angles.

rosette: A dense, radiating cluster of leaves, usually at the base or ground level.

rudimentary: Imperfectly developed or vestigial.

scale: A thin, flat structure.

schizocarp: Dry, indehiscent fruit that splits into separate one-seeded segments at maturity.

scute: Enlarged scale-like plates on a turtle shell.

sedge: Member of a monocot family (Cyperaceae), whose members resemble grasses.

sepal: A segment of the calyx of a flower.

serrate: Saw-like teeth pointing forward; used for leaf margins.

serrulate: Toothed with small, sharp, forward-pointing teeth.

sessile: Attached directly without a stalk.

sheath (sheathing): The leaf base of a grass that surrounds the stem.

simple: Undivided, used for leaf blades and fronds.

sorus (sori): A cluster of spore-bearing structures or sporangia on the undersurface of a fern leaf.

spathe: A large bract at the base or enclosing an inflorescence.

spatulate: Shaped like a spatula, rounded above, tapering at the base.

spike: An unbranched inflorescence with sessile flowers maturing from the bottom upwards.

spikelet: The flower cluster of grasses and sedges.

spur: A short shoot or stem bearing leaves, flowers, or fruits.

stamen: The male part of a flower composed of a filament and anther.

staminal column: A flower structure formed by the fused or united filaments of the stamens.

staminate: Bearing stamens, the male part of a flower, but not pistils, the female part.

staminode: A modified stamen that is sterile and lacks anthers, the pollen-bearing structures.

standard: The upper and largest petal of a flower of the Pea Family (Fabaceae, Faboideae or Papilionoideae Subfamily).

stellate: Star-shaped; used for hairs with many branches radiating from a base.

stigma: The part of the pistil or female part of the flower, which is receptive to pollen.

stipe: A stalk supporting a structure; used for the basal stalk that supports the frond of ferns.

stipule: A pair of leaf-like appendages at the base of a leaf petiole.

stolon: A horizontal stem creeping along the ground; as in grasses.

strigose: Bearing straight, stiff, appressed hairs; used for leaf surfaces.

style: The narrow part of the pistil, or female part of the flower, that connects the stigma to the ovary.

subdigitate: Almost digitate, or arranged like the fingers of a hand from a common point; used for veins, compound leaves, or inflorescences.

subglobose: Almost globose or spherical.

suborbicular: Almost circular.

sub-shrub: A small shrub or woody perennial plant.

succulent: Fleshy and juicy, like the stem of a cactus.

sulcate: Grooved or furrowed.

suture: Junction of plates on a turtle's head or body.

tendril: A slender, twining organ used to support a climbing plant; usually arising from a leaf axil.

tepal: A segment of the perianth (sepal or petal) of a flower, which is not differentiated into calyx and corolla.

terminal: At the tip; used for leaflets and inflorescences.

truncate: Squared at the end, as if cut off; used for leaf apex and base.

tube (corolla): A hollow cylinder, at the base of many tubular flowers.

tuberous: Resembling or producing tubers, which are underground stems modified for food storage.

turgid: Swollen or inflated.

umbel: A flat-topped inflorescence with the flower stalks or pedicels arising from a common point, like the ribs of an umbrella.

unisexual: Bearing flowers of only one sex, male or female.

utricle: A small, thin-walled, one-seeded, inflated fruit.

valve: A segment of a dehiscent fruit, separating at maturity.

villous: Covered with long, soft, non-matted hairs.

whorl: A ring of similar parts arising from a common point or node; used for leaves and flowers.

winged: Having a thin, flat margin.

Appendix

List of Scientific and Common Names of Plants and Animals Used in Accounts

Mammals

(*Scientific Name*, Common Name)

Axis axis, Axis deer

Bos taurus, Cattle, feral cattle

Canis familiaris, Dog, feral dog

Capra hircus, Goat, feral goat

Equus caballus, Horse

Felis sylvestris catus, House cat, feral cat, cat

Herpestes auropunctatus, Small Indian mongoose, mongoose

Lasiurus cinereus subsp. *semotus*, `Ōpe`ape`a, Hawaiian hoary bat

Mirounga angustirostris, Elephant seal

Monachus schauinslandi, `Ilio holo I ka uaua, Hawaiian monk seal

Mus musculus, House mouse

Ovis aries, Sheep, feral sheep

Ovis gmelini musimon, Mouflon sheep

Rattus exulans, Polynesian rat

Rattus rattus, Black rat, roof rat

Sus scrofa scrofa, Pig, feral pig

(Common Name, *Scientific Name*)

Axis deer, *Axis axis*

Black rat, *Rattus rattus*

Cattle, *Bos taurus*

Dog, *Canis familiaris*

Elephant seal, *Mirounga angustirostris*

Feral cat, *Felis sylvestris catus*

Feral cattle, *Bos taurus*

Feral dog, *Canis familiaris*

Feral goat, *Capra hircus*

Feral pig, *Sus scrofa scrofa*

Feral sheep, *Ovis aries*

Goat, feral, *Capra hircus*

Horse, *Equus caballus*

House cat, *Felis catus*

House mouse, *Mus musculus*

`Ilio holo I ka uaua, Hawaiian monk seal, *Monachus schauinslandi*

Mongoose, small Indian, *Herpestes auropunctatus*

Mouflon sheep, *Ovis gmelini musimon*

`Ōpe`ape`a, Hawaiian hoary bat, *Lasiurus cinereus* subsp. *semotus*

Pig, feral, *Sus scrofa scrofa*

Polynesian rat, *Rattus exulans*

Roof rat, *Rattus rattus*

Sheep, feral, *Ovis aries*

Small Indian mongoose, *Herpestes auropunctatus*

APPENDIX, continued

Birds

(*Scientific Name*, Common Name)

Acridotheres tristis, Common myna
Anous minutus, Black noddy
Asio flammeus sandwicensis, Pueo, Short-eared owl
Branta canadensis, Canada goose
Branta sandwicensis, **Nēnē, Hawaiian goose**
Buteo lagopus, Rough-legged hawk
Buteo solitarius, `Io, Hawaiian hawk
Cardinalis cardinalis, Northern cardinal
Carpodacus mexicanus, House finch
Chaetoptila angustipluma, Kioea
Corvus brachyrhynchos, American crow
Corvus hawaiiensis, `Alalā, Hawaiian crow
Drepanis pacifica, Hawai`i mamo
Falco peregrinus tundrius, Peregrine falcon
Hemignathus munroi, **`Akiapōlā`au**
Hemignathus obscurus obscurus, Hawaiian `akialoa
Hemignathus virens, Hawai`i `amakihī
Lophura leucomelanos, Kalij pheasant
Loxops coccineus coccineus, Hawai`i `ākepa
Loxops coccineus ochraceus, **Maui `ākepa**
Moho nobilis, Hawai`i `ō`ō
Numenius phaeopus, Whimbrel
Numenius tahitiensis, Kioea, bristle-thighed curlew
Oceanodroma castro, `Ake`ake, band-rumped storm-petrel
Oreomystis mana, Hawai`i creeper
Pluvialis fulva, Pacific golden plover
Porzana sandwichensis, Moho, Hawaiian rail
Psittirostra psittacea, **`Ō`ū**
Pterodroma phaeopygia, Galápagos petrel
Pterodroma sandwichensis, `Ua`u, Hawaiian petrel
Puffinus auricularis newelli, `A`o
Puffinus pacificus, Wedge-tailed shearwater
Rhodacanthis palmeri, Greater koa finch
Tyto alba, Barn owl
Zosterops japonicus, Japanese white-eye

(Common Name, *Scientific Name*)

`Ake`ake, band-rumped storm-petrel, *Oceanodroma castro*
`Akiapōlā`au, *Hemignathus munroi*
`Alalā, Hawaiian crow, *Corvus hawaiiensis*
American crow, *Corvus brachyrhynchos*
`A`o, *Puffinus auricularis newelli*
Band-rumped storm-petrel, `ake`ake, *Oceanodroma castro*
Barn owl, *Tyto alba*
Black noddy, *Anous minutus*

APPENDIX, continued

Birds, continued

(Common Name, *Scientific Name*)

Bristle-thighed curlew, Kioea, *Numenius tahitiensis*

Canada goose, *Branta canadensis*

Common myna, *Acridotheres tristis*

Galápagos petrel, *Pterodroma phaeopygia*

Greater koa finch, *Rhodacanthis palmeri*

Hawai`i `akepa, *Loxops coccineus coccineus*

Hawai`i `amakihi, *Hemignathus virens*

Hawai`i creeper, *Oreomystis mana*

Hawai`i mamo, *Drepanis pacifica*

Hawai`i `ō`ō, *Moho nobilis*

Hawaiian `akialoa, *Hemignathus obscurus obscurus*

Hawaiian petrel, `Ua`u, *Pterodroma sandwichensis*

House finch, *Carpodacus mexicanus*

`Io, Hawaiian hawk, *Buteo solitarius*

Japanese white-eye, *Zosterops japonicus*

Kalij pheasant, *Lophura leucomelanos*

Kioea, *Chaetoptiila angustipluma*

Kioea, bristle-thighed curlew, *Numenius tahitiensis*

Maui `akepa, *Loxops coccineus ochraceus*

Moho, Hawaiian rail, *Porzana sandwichensis*

Nēnē, Hawaiian goose, *Branta sandvicensis*

Northern cardinal, *Cardinalis cardinalis*

`Ō`ū, *Psittirostra psittacea*

Pacific golden plover, *Pluvialis fulva*

Peregrine falcon, *Falco peregrinus tundrius*

Pueo, short-eared owl, *Asio flammeus sandwichensis*

Rough-legged hawk, *Buteo lagopus*

`Ua`u, Hawaiian petrel, *Pterodroma sandwichensis*

Wedge-tailed shearwater, *Puffinus pacificus*

Whimbrel, *Numenius phaeopus*

Reptiles

(*Scientific Name*, Common Name)

Chelonia mydas, Honu, green sea turtle

Dermochelys coriacea, Leatherback turtle

Eretmochelys imbricata, Honu `ea, hawksbill turtle

(Common Name, *Scientific Name*)

Honu, green sea turtle, *Chelonia mydas*

Honu `ea, hawksbill turtle, *Eretmochelys imbricata*

Leatherback turtle, *Dermochelys coriacea*

Fish

(*Scientific Name*, Common Name)

Abedefduf sordidus, Kūpīpī

APPENDIX, continued

Fish, continued

(*Scientific Name*, Common Name)

Acanthurus sandvicensis, Manini

Bathygobius fuscus, Goby, `o` opu

Caranx ferdau, Papio

Eleotris sandvicensis, Goby, `o` opu

Gambusia affinis, Mosquitofish

Galeocerdo cuvier, Tiger shark

Kuhlia sandvicensis, **Āholehole**

Poecilia reticulata and other fish of the Poeciliidae Family, guppies

(Common Name, *Scientific Name*)

Āholehole, *Kuhlia sandvicensis*

Goby, `o` opu, *Eleotris sandvicensis*, *Bathygobius fuscus*

Guppies, *Poecilia reticulata* and other fish of the Poeciliidae

Kūpīpī, *Abedefduf sordidus*

Manini, *Acanthurus sandvicensis*

Mosquitofish, *Gambusia affinis*

`O` opu, *Eleotris sandvicensis*, *Bathygobius fuscus*

Papio, *Caranx ferdau*

Tiger shark, *Galeocerdo cuvier*

Crustaceans

(*Scientific Name*, Common Name)

Halocaridina rubra, `Ōpae `ula

Macrobrachium grandimanus, `Ōpae kāla`ole

Macrobrachium lar, Tahitian prawn

Metabetaeus lohena, Scavenging anchialine pool shrimp

Metapograpsus thukuhar, Grapsid crab

Palaemon debilis, `Ōpae huna

(Common Name, *Scientific Name*)

Grapsid crab, *Metapograpsus thukuhar*

`Ōpae huna, *Palaemon debilis*

`Ōpae kāla`ole, *Macrobrachium grandimanus*

`Ōpae `ula, *Halocaridina rubra*

Scavenging anchialine pool shrimp, *Metabetaeus lohena*

Tahitian prawn, *Macrobrachium lar*

Insects and Invertebrates

(*Scientific Name*, Common Name)

Adoretus sinicus, Chinese rose beetle

Aleurodicus dispersus, Spiralling white-fly

Ascalapha odorata, Black witch moth

Culex quinquefasciatus, Night-flying mosquito

Drosophila digressa, **Pāpala picture-wing fly**

Drosophila heteroneura, Hammerhead picture-wing fly

APPENDIX, continued

Insects and Invertebrates, continued

(*Scientific Name*, Common Name)

Drosophila melanogaster, Fruit fly
Drosophila mulli, **Mull's picture**-wing fly
Drosophila ochrobasis, Enigmatic picture-wing fly
Drosophila setosimentum, Picture-wing fly
Drosophila silvestris, Forest picture-wing fly
Hylaeus spp., Yellow-faced bees
Limax maximus, Leopard slug
Linepithema humile, Argentine ant
Megalagrion koelense, Koele Mountain damselfly
Megalagrion nesiotes, Flying earwig damselfly
Megalagrion oahuense, O`ahu damselfly
Megalagrion xanthomelas, Orange-black damselfly
Musca domestica, House fly
Prays spp., native moth in Yponomeutidae Family
Quadrastichus erythrinae, Erythrina gall wasp
Sophonia rufofasiata, Two-spotted leafhopper
Vespula pensylvanica, Western yellowjacket wasp
Xylosandrus compactus, Black twig-borer

(Common Name, *Scientific Name*)

Argentine ant, *Linepithema humile*
Black twig-borer, *Xylosandrus compactus*
Chinese rose beetle, *Adoretus sinicus*
Enigmatic picture-wing fly, *Drosophila ochrobasis*
Erythrina gall wasp, *Quadrastichus erythrinae*
Flying earwig damselfly, *Megalagrion nesiotes*
Forest picture-wing fly, *Drosophila silvestris*
Fruit fly, *Drosophila melanogaster*
Hammerhead picture-wing fly, *Drosophila heteroneura*
House fly, *Musca domestica*
Koele Mountain damselfly, *Megalagrion koelense*
Leopard slug, *Limax maximus*
Mull's picture-wing fly, *Drosophila mulli*
Night-flying mosquito, *Culex quinquefasciatus*
O`ahu damselfly, *Megalagrion oahuense*
Orange-black damselfly, *Megalagrion xanthomelas*
Pāpala picture-wing fly, *Drosophila digressa*
Spiralling white-fly, *Aleurodicus dispersus*
Two-spotted leafhopper, *Sophonia rufofasiata*
Western yellowjacket wasp, *Vespula pensylvanica*
Yellow-faced bees, *Hylaeus* spp.

APPENDIX, continued

Algae

(*Scientific Name*, Common Name)

Lyngbya spp., Blue-green algae

Schizothrix spp., Blue-green algae

(Common Name, *Scientific Name*)

Blue-green algae, *Lyngbya* spp., *Schizothrix* spp.

Plants

(*Scientific Name*, Common Name)

Abutilon grandifolium, Hairy abutilon

Abutilon pictum, Egg hibiscus

Acacia koa, Koa

Adenophorus periens, **Palai lā`au**

Adenophorus pinnatifidus, No common name

Aleurites moluccana, Kukui

Alphitonia ponderosa, Kauila

Alyxia stellata, Maile

Andropogon virginicus, Broomsedge

Anoectochilus sandvicensis, Jewel orchid, honohono

Anthoxanthum odoratum, Sweet vernal grass

Argyroxiphium kauense, `Āhinahina, Ka`ū silversword, Mauna Loa silversword

Argyroxiphium sandwicense subsp. *macrocephalum*, `Āhinahina, Haleakalā silversword

Argyroxiphium sandwicense subsp. *sandwicense*, `Āhinahina, Mauna Kea silversword

Asplenium adiantum-nigrum, `Iwa`iwa

Asplenium haleakalense, No common name

Asplenium macraei, `Iwa`iwa lau li`i

Asplenium monanthes, No common name

Asplenium peruvianum var. *insulare*, Island Peruvian spleenwort

Asplenium schizophyllum, Cut-leaved spleenwort

Asplenium sphenotomum, No common name

Asplenium trichomanes subsp. *densum*, `Oāli`i

Astelia menziesiana, Pa`iniu

Bidens cynapiifolia, No common name

Bidens hawaiiensis, Ko`oko`olau

Bidens pilosa, Spanish needle

Bobea elatior, `Ahakea

Bobea timonioides, `Ahakea

Bulbostylis capillaris, No common name, alien sedge

Caesalpinia kavalensis, Uhiuhi

Capparis cordifolia, Pacific caper bush

Capparis sandwichiana, Pua pilo, maiapilo

Carex wahuensis, No common name, native sedge

Chamaecrista nictitans, Japanese tea

Charpentiera obovata, **Pāpala**

Cheirodendron trigynum, `Ōlapa

Chrysopogon aciculatus, Pilipili`ula, golden beardgrass

APPENDIX, continued

Plants, continued

(Scientific Name, Common Name)

Cibotium glaucum, Hāpu`u pulu

Cibotium spp., Hāpu`u, tree ferns

Ciclospermum leptophyllum, Fir-leaved celery

Cleome gynandra, Wild spider flower

Cleome spinosa, Honohino, spider flower

Clermontia hawaiiensis, `Ōhā kēpau

Clermontia lindseyana, `Ōhā, Lindsey's `ōhā

Clermontia montis-loa, `Ōhā, Mauna Loa `ōhā

Clermontia peleana, `Ōhā, Pele's `ōhā

Clermontia spp., `Ōhā

Clidemia hirta, Koster's curse

Cocos nucifera, Niu, coconut

Colubrina oppositifolia, Kauila

Commelina diffusa, Dayflower

Coprosma ernodeoides, Kūkaenēnē

Coprosma menziesii, Pilo

Coprosma rynchocarpa, Pilo

Cotula australis, Australian coat buttons

Cyanea marksii, Hāhā

Cyanea pilosa subsp. *longipedunculata*, Hāhā

Cyanea platyphylla, `Akū`akū

Cyanea shipmanii, Hāhā, Shipman's hāhā

Cyanea stictophylla, Hāhā

Cyanea tritomantha, `Akū

Cynodon dactylon, Bermuda grass

Cyperus laevigatus, Makaloa

Cyperus polystachyos, No common name, native sedge

Cyrtandra giffardii, Ha`iwale, Giffard's ha`iwale

Cyrtandra lysiosepala, Ha`iwale

Cyrtandra menziesii, Ha`iwale, Menzies' ha`iwale

Cyrtandra platyphylla, `Ilihia

Cyrtandra tintinnabula, Ha`iwale, Bell ha`iwale

Daucus pusillus, Wild carrot

Deschampsia nubigena, No common name, endemic bunchgrass

Desmodium triflorum, Three-flowered beggarweed

Dicranopteris linearis, Uluhe

Digitaria ciliaris, Henry's crabgrass

Digitaria spp., Crabgrass

Diospyros sandwicensis, Lama

Dodonaea viscosa, `A`ali`i

Dryopteris fusco-atra, `I`i

Dryopteris wallichiana, Laukāhi

Dubautia arborea, Na`ena`e

Dubautia ciliolata subsp. *glutinosa*, Na`ena`e

APPENDIX, continued

Plants, continued

(Scientific Name, Common Name)

Ehrharta stipoides, Meadow ricegrass

Embellia pacifica, Kilioe

Erythrina sandwicensis, Wiliwili

Erythrina variegata, Indian coral tree

Eurya sandwicensis, **Ānini**

Exocarpos gaudichaudii, Hulumoa

Exocarpos menziesii, Heau

Fimbristylis cymosa, Mau`u`aki`aki

Fimbristylis dichotoma, No common name, native sedge

Fimbristylis hawaiiensis, Hawaiian fringed sedge

Fragaria chiloensis subsp. *sandwicensis*, **`Ōhelo papa, Hawaiian strawberry**

Fragaria vesca, European white strawberry

Freycinetia arborea, `Ie`ie

Grevillea robusta, Silky oak

Hedychium gardnerianum, **Kāhili ginger**

Heteropogon contortus, Pili

Hibiscadelphus giffardianus, Hau kuahiwi

Hibiscadelphus hualalaiensis, Hau kuahiwi

Hibiscus brackenridgei subsp. *brackenridgei*, Ma`o hau hele

Hibiscus spp., Hibiscus

Holcus lanatus, Velvet grass

Hyparrhenia rufa, African thatching grass

Hypochoeris radicata, Gosmore

Indigofera suffruticosa, Indigo

Ipomoea indica, Koali`awa

Ipomoea pes-caprae subsp. *brasiliensis*, **Pōhuehue**

Ischaemum byrone, Hilo ischaemum

Jacquemontia ovalifolia subsp. *sandwicensis*, **Pa`ū o Hi`iaka**

Joinvillea ascendens subsp. *ascendens*, `Ohe

Kadua affinis, Manono

Kadua centranthoides, No common name, endemic species in coffee family, Rubiaceae

Kokia cookei, Koki`o

Kokia drynarioides, Koki`o

Kokia kauaiensis, Koki`o

Kokia lanceolata, Koki`o

Lantana camara, Lantana

Leptecophylla tameiameiaae, **Pūkiawe**

Leucaena leucocephala, Koa haole

Liparis hawaiiensis, `Awapuhi a Kanaloa, twayblade

Lycopodiella cernua, **Wāwae`iole**

Marattia douglasii, Pala

Melicope hawaiiensis, Manena

Melicope pseudoanisata, Alani

Melicope radiata, Alani

Melicope zahlbruckneri, **Alani, Zahlbruckner's alani**

APPENDIX, continued

Plants, continued

(Scientific Name, Common Name)

Melinis minutiflora, Molasses grass
Melinis repens, Natal red-top grass
Metrosideros polymorpha, `Ōhi` a lehua
Microlepia strigosa, Palapalai
Morella faya, Faya, Firetree
Morelotia gahniiformis, No common name, native sedge
Morinda citrifolia, Noni
Myoporum sandwicense, Naio
Myrsine lanaiensis, Kōlea, Lāna`i kōlea
Myrsine lessertiana, Kōlea, kōlea lau nui
Nephrolepis cordifolia, Kupukupu
Nephrolepis exaltata subsp. *hawaiiensis*, Kupukupu
Nephrolepis multiflora, Asian swordfern
Neraudia ovata, Ovate ma`aloa
Nestegis sandwicensis, Olopua
Nothoestrum breviflorum, `Aiea, short-flowered `aiea
Nothoestrum longifolium, `Aiea, long-leaved `aiea
Ochrosia haleakalae, Hōle`i, Haleakalā hōlei
Ochrosia kilaueaensis, Hōle`i, Kīlauea hōlei
Ochrosia sandwicensis = *O. compta*, Hōle`i
Olea europaea subsp. *cuspidata*, African olive
Osteomeles anthyllidifolia, `Ūlei
Oxalis corniculata, `Ihi
Panicum tenuifolium, Mountain pili
Parthenium hysterophorus, False ragweed
Paspalum urvillei, Vasey grass
Passiflora foetida, Love-in-a-mist, scarlet-fruited passionflower
Passiflora ligularis, Sweet granadilla
Passiflora tarminiana, Banana poka
Pelea kilaueaensis = *Melicope hawaiiensis*
Pellaea ternifolia, Kalamoho lau li`i
Pennisetum setaceum, Fountain grass
Peperomia blanda, `Ala`alawainui
Peperomia cookiana, `Ala`alawainui
Petroselinum crispum, Parsley
Phaius tankarvilleae, Chinese ground orchid
Phyllostegia ambigua, Ambiguous Hawaiian mint
Phyllostegia floribunda (includes *P. villosa*), Many-flowered Hawaiian mint
Phyllostegia macrophylla, Large-leaved Hawaiian mint
Phyllostegia stachyoides, Stachys-like Hawaiian mint
Phyllostegia velutina, Velvety Hawaiian mint
Phyllostegia vestita, Clothed Hawaiian mint
Phymatosorus grossus, Laua`e
Physalis peruviana, Poha
Phytolacca octandra, Southern pokeweed

APPENDIX, continued

Plants, continued

(Scientific Name, Common Name)

Phytolacca sandwicensis, Pōpolo kū mai
Pipturus albidus, Māmaki
Pisonia brunoniana, Pāpala kēpau
Pittosporum hawaiiense, Hō`awa, Hawai`i hō`awa
Pittosporum hosmeri, Hō`awa
Pittosporum terminalioides, Hō`awa
Plantago hawaiiensis, Laukahi kuahiwi
Plantago major, Common plantain
Plantago pachyphylla, Laukahi kuahiwi
Plectranthus parviflorus, Spurflower
Pleomele aurea, Hala pepe
Pleomele hawaiiensis, Hala pepe
Pluchea carolinensis, Sourbush
Portulaca oleracea, Purslane, `Ihi
Portulaca pilosa, `Ihi
Portulaca sclerocarpa, `Ihi mākole, Po`e
Portulaca spp., `Ihi
Portulaca villosa, `Ihi
Pritchardia affinis, Loulu
Pritchardia beccariana, Loulu
Prosopis pallida, Kiawe
Psidium cattleianum, Strawberry guava, Waiawī
Psidium guajava, Common guava
Psychotria hawaiiensis var. *hillebrandii*, Kōpiko`ula
Psydrax odorata, Alahe`e
Pteridium aquilinum subsp. *decompositum*, Bracken fern
Pteris cretica, Cretan brake fern
Ranunculus hawaiiensis, Makou, Hawai`i makou
Ranunculus mauiensis, Makou, Maui makou
Ranunculus plebeius, Common Australian buttercup
Rauvolfia sandwicensis, Hao
Reynoldsia sandwicensis, `Ohe mākai
Rubus argutus, Prickly blackberry
Rubus ellipticus var. *obcordatus*, Yellow Himalayan raspberry
Rubus hawaiiensis, `Ākala, Hawaiian raspberry
Rubus macraei, `Ākala, Macrae's raspberry
Sanicula sandwicensis, Snakeroot
Santalum paniculatum, `Iliahi, sandalwood
Sapindus saponaria, Mānele, `ae, soapberry
Scaevola chamissoniana, Naupaka kuahiwi
Scaevola kilaueae, Huakekili uka, Kīlauea naupaka
Scaevola taccada, Naupaka kahakai
Schiedea diffusa subsp. *macraei*, Macrae's spreading schiedea (No common name)
Schinus terebinthifolius, Christmas berry
Schizachyrium condensatum, Bush beardgrass

APPENDIX, continued

Plants, continued

(*Scientific Name*, Common Name)

Sechium edule, Chayote, pipinella

Senna gaudichaudii, Kolomona

Sesbania tomentosa, `Ōhai

Sesuvium portulacastrum, `Akulikuli

Setaria palmifolia, Palmgrass

Sicyos alba, `Ānunu, white `ānunu

Sicyos anunu, `Ānunu

Sicyos macrophyllus, `Ānunu, large-leaved `ānunu

Sida fallax, `Ilima

Silene hawaiiensis, Hawaiian catchfly

Silene struthioloides, Catchfly, no specific common name

Sisyrinchium acre, Mau`u lā`ili

Solanum pseudocapsicum, Jerusalem cherry

Soliva sessilis, No common name, alien herb in parsley family, Apiaceae

Sophora chrysophylla, Māmane

Spermolepis hawaiiensis, Hawaiian scaly-seed

Stenogyne angustifolia, Narrow-leaved Hawaiian mint

Stenogyne calaminthoides, Hawaiian mint

Stenogyne macrantha, Large-flowered Hawaiian mint

Stenogyne rugosa, Mā`ohi`ohi

Stenogyne scrophularioides, Mōhihi

Tephrosia purpurea, `Auhuhu

Tetraplasandra hawaiiensis, `Ohe

Tetraplasandra kavaiensis, `Ohe`ohe

Tetraplasandra oahuensis, `Ohe mauka

Thespesia populnea, Milo

Tibouchina herbacea, Cane tibouchina

Trematolobelia wimmeri, Koli`i, Wimmer's koli`i

Tropaeolum majus, Nasturtium

Vaccinium calycinum, `Ōhelo kau lā`au

Vaccinium reticulatum, `Ōhelo

Verbascum thapsus, Common mullein

Vigna marina, Nanea

Waltheria indica, `Uhaloa

Xylosma hawaiiense, Maua

Zanthoxylum dipetalum var. *dipetalum*, Kāwa`u

Zanthoxylum hawaiiense, A`e, Hawai`i a`e

Zanthoxylum kauaense, A`e, Kaua a`e

APPENDIX, continued

Plants, continued

(Common Name, *Scientific Name*)

`A`ali`i, *Dodonaea viscosa*

A`e, Hawai`i a`e, *Zanthoxylum hawaiiense*

A`e, Kaua a`e, *Zanthoxylum kauaense*

African olive, *Olea europaea* subsp. *cuspidata*

African thatching grass, *Hyparrhenia rufa*

`Ahakea, *Bobea timonioides*, *Bobea elatior*

`**Āhinahina**, *Argyroxiphium kauense*, *Argyroxiphium sandwicense* subsp. *macrocephalum*,
Argyroxiphium sandwicense subsp. *sandwicense*

`Aiea, long-leaved `aiea, *Nothoctrum longifolium*

`Aiea, short-flowered `aiea, *Nothoctrum breviflorum*

`**Ākala**, Hawaiian raspberry, *Rubus hawaiiensis*, *Rubus macraei*

`**Ākū**, *Cyanea tritomantha*

`**Ākū`akū**, *Cyanea platyphylla*

`Akulikuli, *Sesuvium portulacastrum*

`Ala`alawainui, *Peperomia blanda*, *P. cookiana*

Alahe`e, *Psydrax odorata*

Alani, *Melicope pseudoanisata*, *Melicope radiata*

Alani, Zahlbruckner's alani, *Melicope zahlbruckneri*

Ambiguous Hawaiian mint, *Phyllostegia ambigua*

Ānini, *Eurya sandwicensis*

`**Ānunu**, *Sicyos anunu*

`**Ānunu**, white `ānunu, *Sicyos alba*

`**Ānunu**, large-leaved `ānunu, *Sicyos macrophyllus*

Asian swordfern, *Nephrolepis multiflora*

`Auhuhu, *Tephrosia purpurea*

Australian coat buttons, *Cotula australis*

`Awapuhi a Kanaloa, *Liparis hawaiiensis*

Banana poka, *Passiflora tarminiana*

Bermuda grass, *Cynodon dactylon*

Bracken fern, *Pteridium aquilinum* subsp. *decompositum*

Broomsedge, *Andropogon virginicus* Bush beardgrass, *Schizachyrium condensatum*

Cane tibouchina, *Tibouchina herbacea*

Catchfly, *Silene struthioloides*

Chayote, pipinella, *Sechium edule*

Chinese ground orchid, *Phaius tankarvilleae*

Christmas berry, *Schinus terebinthifolius*

Clothed Hawaiian mint, *Phyllostegia vestita*

Coconut, *Cocos nucifera*

Common Australian buttercup, *Ranunculus plebeius*

Common guava, *Psidium guajava*

Common mullein, *Verbascum thapsus*

Common plantain, *Plantago major*

Crabgrass, *Digitaria* spp.

Cretan brake fern, *Pteris cretica*

Cut-leaved spleenwort, *Asplenium schizophyllum*

APPENDIX, continued

Plants, continued

(Common Name, *Scientific Name*)

Dayflower, *Commelina diffusa*

Egg hibiscus, *Abutilon pictum*

Endemic bunchgrass with no common name, *Deschampsia nubigena*

European white strawberry, *Fragaria vesca*

False ragweed, *Parthenium hysterophorus*

Faya, firetree, *Morella faya*

Fir-leaved celery, *Ciclospermum leptophyllum*

Fountain grass, *Pennisetum setaceum*

Gosmore, *Hypochoeris radicata*

Hāhā, *Cyanea shipmanii*, *C. stictophylla*, *C. marksii*, *C. pilosa* subsp. *longipedunculata*

Hairy abutilon, *Abutilon grandifolium*

Ha`iwale, *Cyrtandra lysiosepala*

Ha`iwale, bell ha`iwale, *Cyrtandra tintinnabula*

Ha`iwale, Giffard's ha`iwale, *Cyrtandra giffardii*

Ha`iwale, **Menzies' ha`iwale**, *Cyrtandra menziesii* Hala pepe, *Pleomele hawaiiensis*, *P. aurea*

Haleakalā silversword, *Argyroxiphium sandwicense* subsp. *macrocephalum*

Hao, *Rauvolfia sandwicensis*

Hāpu`u pulu, *Cibotium glaucum*

Hāpu`u, tree ferns, *Cibotium* spp.

Hau kuahiwi, *Hibiscadelphus giffardianus*, *Hibiscadelphus hualalaiensis*

Hawaiian catchfly, *Silene hawaiiensis*

Hawaiian fringed sedge, *Fimbristylis hawaiiensis*

Hawaiian scaly-seed, *Spermolepis hawaiiensis*

Hawaiian strawberry, *Fragaria chiloensis* subsp. *sandwicensis*

Heau, *Exocarpos menziesii*

Henry's crabgrass, *Digitaria ciliaris*

Hibiscus, *Hibiscus* spp.

Hilo ischaemum, *Ischaemum byrone*

Hō`awa, *Pittosporum hawaiiense*, *P. hosmeri*, *P. terminalioides*

Hōle`i, Haleakalā hōlei, *Ochrosia haleakalae*

Hōle`i, Kīlauea hōlei, *Ochrosia kilaueaensis*

Huakekili uka, Kīlauea naupaka, *Scaevola kilaueae*

Hulumoa, *Exocarpos gaudichaudii*

`Ie`ie, *Freycinetia arborea*

`Ihi, *Portulaca pilosa*, *P. villosa*, *Portulaca* spp., *Oxalis corniculata*

`Ihi mākole, po`e, *Portulaca sclerocarpa*

`I`i, *Dryopteris fusco-atra*

`Iliahi, *Santalum paniculatum*

`Ilihia, *Cyrtandra platyphylla*

`Ilima, *Sida fallax*

Indian coral tree, *Erythrina variegata*

Indigo, *Indigofera suffruticosa*

Island Peruvian spleenwort, *Asplenium peruvianum* var. *insulare*

APPENDIX, continued

Plants, continued

(Common Name, *Scientific Name*)

`Iwa`iwa, *Asplenium adiantum-nigrum*

`Iwa`iwa lau li`i, *Asplenium macraei*

Japanese tea, *Chamaecrista nictitans*

Jerusalem cherry, *Solanum pseudocapsicum*

Jewel orchid, Honohono, *Anoectochilus sandwicensis*

Kāhili ginger, *Hedychium gardnerianum*

Kalamoho lau li`i, *Pellaea ternifolia*

Kauila, *Alphitonia ponderosa*, *Colubrina oppositifolia*

Ka`ū silversword, *Argyroxiphium kauense*

Kāwa`u, *Zanthoxylum dipetalum* var. *dipetalum*

Kiawe, *Prosopis pallida*

Kīlauea naupaka, *Scaevola kilaueae*

Kilioe, *Embelia pacifica*

Koa, *Acacia koa*

Koa haole, *Leucaena leucocephala*

Koali`awa, *Ipomoea indica*

Koki`o, *Kokia cookei*, *K. drynarioides*, *K. kauaiensis*, *K. lanceolata*

Kōlea, **Lāna`i kōlea**, *Myrsine lanaiensis*

Kōlea lau nui, *Myrsine lessertiana*

Koli`i, **Wimmer's koli`i**, *Trematolobelia wimmeri*

Kolomona, *Senna gaudichaudii*

Ko`oko`olau, *Bidens hawaiiensis*

Kōpiko`ula, *Psychotria hawaiiensis* var. *hillebrandii*

Koster's curse, *Clidemia hirta*

Kūkaenēnē, *Coprosma ernodeoides*

Kukui, *Aleurites moluccana*

Kupukupu, *Nephrolepis exaltata* subsp. *hawaiiensis*, *N. cordifolia*

Lama, *Diospyros sandwicensis*

Lantana, *Lantana camara*

Large-flowered Hawaiian mint, *Stenogyne macrantha*

Large-leaved Hawaiian mint, *Phyllostegia macrophylla*

Laua`e, *Phymatosorus grossus*

Laukāhi, *Dryopteris wallichiana*

Laukāhi kuahiwi, *Plantago hawaiiensis*, *P. pachyphylla*

Loulu, *Pritchardia affinis*, *P. beccariana*

Love-in-a-mist, scarlet-fruited passionflower, *Passiflora foetida*

Macrae's raspberry, **`Ākala**, *Rubus macraei*

Macrae's spreading schiedea, *Schiedea diffusa* subsp. *macraei*

Maile, *Alyxia stellata*

Makaloa, *Cyperus laevigatus*

Makou, Hawai`i makou, *Ranunculus hawaiiensis*

Makou, Maui makou, *Ranunculus mauiensis*

Māmaki, *Pipturus albidus*

Māmane, *Sophora chrysophylla*

Mānele, *Sapindus saponaria*

APPENDIX, continued

Plants, continued

(Common Name, *Scientific Name*)

Manena, *Melicope hawaiiensis*

Manono, *Kadua affinis*

Many-flowered Hawaiian mint, *Phyllostegia floribunda*

Ma`o hau hele, *Hibiscus brackenridgei* subsp. *brackenridgei*

Mā`ohi`ohi, *Stenogyne rugosa*

Maua, *Xylosma hawaiiense*

Mauna Kea silversword, `āhinahina, *Argyroxiphium sandwicense* subsp. *sandwicense*

Mauna Loa silversword, `āhinahina, *Argyroxiphium kauense*

Mau`u`aki`aki, *Fimbristylis cymosa*

Mau`u lā`ili, *Sisyrinchium acre*

Meadow ricegrass, *Ehrharta stipoides*

Milo, *Thespesia populnea*

Mōhihi, *Stenogyne scrophularioides*

Molasses grass, *Melinis minutiflora*

Mountain pili, *Panicum tenuifolium*

Na`ena`e, *Dubautia arborea*, *D. ciliolata* subsp. *glutinosa*

Naio, *Myoporum sandwicense*

Nanea, *Vigna marina*

Narrow-leaved Hawaiian mint, *Stenogyne angustifolia*

Nasturtium, *Tropaeolum majus*

Natal red-top grass, *Melinis repens*

Native sedges with no common names, *Carex wahuensis*, *Cyperus polystachyos*,
Fimbristylis dichotoma, *Morelotia gahniiformis*

Naupaka kahakai, *Scaevola taccada*

Naupaka kuahiwi, *Scaevola chamissoniana*

Niu, *Cocos nucifera*

Noni, *Morinda citrifolia*

`Oāli`i, *Asplenium trichomanes* subsp. *densum*

`Ōhā, *Clermontia* spp.

`Ōhā, Lindsey's `ōhā, *Clermontia lindseyana*

`Ōhā, Mauna Loa `ōhā, *Clermontia montis-loa*

`Ōhā, Pele's `ōhā, *Clermontia peleana*

`Ōhā kēpau, *Clermontia hawaiiensis*

`Ōhai, *Sesbania tomentosa*

`Ohe, *Joinvillea ascendens* subsp. *ascendens*

`Ohe, *Tetraplasandra hawaiiensis*

`Ohe māakai, *Reynoldsia sandwicensis*

`Ohe mauka, *Tetraplasandra oahuensis*

`Ohe`ohe, *Tetraplasandra kawaiiensis*

`Ōhelo, *Vaccinium reticulatum*

`Ōhelo kau lā`au, *Vaccinium calycinum*

`Ōhelo papa, *Fragaria chiloensis* subsp. *sandwicensis*

`Ōhi`a lehua, *Metrosideros polymorpha*

`Ōlapa, *Cheirodendron trigynum*

Olopuā, *Nestegis sandwicensis*

APPENDIX, continued

Plants, continued

(Common Name, *Scientific Name*)

Ovate ma`aloa, *Neraudia ovata*

Pacific caper bush, *Capparis cordifolia*

Pa`iniu, *Astelia menziesiana*

Pala, *Marattia douglasii*

Palai lā`au, *Adenophorus periens*

Palapalai, *Microlepia strigosa*

Palmgrass, *Setaria palmifolia*

Pāpala, *Charpentiera obovata*

Pāpala kēpau, *Pisonia brunoniana*

Parsley, *Petroselinum crispum*

Pa`ū o Hi`iaka, *Jacquemontia ovalifolia* subsp. *sandwicensis*

Pili, *Heteropogon contortus*

Pilipili`ula, *Chrysopogon aciculatus*

Pilo, *Coprosma menziesii*, *Coprosma rhynocharpa*

Pipinella, *Sechium edule*

Po`e, **`Ihi mākole**, *Portulaca sclerocarpa*

Poha, *Physalis peruviana*

Pōhuehue, *Ipomoea pes-caprae* subsp. *brasiliensis*

Pōpolo kū mai, *Phytolacca sandwicensis*

Prickly blackberry, *Rubus argutus*

Pua pilo, maiapilo, *Capparis sandwichiana*

Pūkiawe, *Leptecophylla tameiameia*

Purslane, `Ihi, *Portulaca oleracea*

Sandalwood, `iliahi, *Santalum paniculatum*

Silky oak, *Grevillea robusta*

Snakeroot, *Sanicula sandwicensis*

Soapberry, *Sapindus saponaria*

Sourbush, *Pluchea carolinensis*

Southern pokeweed, *Phytolacca octandra*

Spanish needle, *Bidens pilosa*

Spider flower, honohino, *Cleome spinosa*

Spurflower, *Plectranthus parviflorus*

Stachys-like Hawaiian mint, *Phyllostegia stachyoides*

Strawberry guava, *Psidium cattleianum*

Sweet granadilla, *Passiflora ligularis*

Sweet vernal grass, *Anthoxanthum odoratum*

Three-flowered beggarweed, *Desmodium triflorum*

Twayblade, *Liparis hawaiiensis*

`Uhaloa, *Waltheria indica*

Uhiuhi, *Caesalpinia kawaiiensis*

`Ūlei, *Osteomeles anthyllidifolia*

Uluhe, *Dicranopteris linearis*

Vasey grass, *Paspalum urvillei*

Velvet grass, *Holcus lanatus*

Velvety Hawaiian mint, *Phyllostegia velutina*

APPENDIX, continued

Plants, continued

(Common Name, *Scientific Name*)

Waiawī, *Psidium cattleianum*

Wāwae`iole, *Lycopodiella cernua*

Wild carrot, *Daucus pusillus*

Wild spider flower, *Cleome gynandra*

Wiliwili, *Erythrina sandwicensis*

Yellow Himalayan raspberry, *Rubus ellipticus* var. *obcordatus*