2010 Rare Plant Survey, O‘ahu Forest National Wildlife Refuge,
Waipiʻo, Oʻahu

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Honolulu, Hawaiʻi

October 2011
Cover: A vegetative specimen of an endemic species of *Lobelia*, likely the federally listed Endangered *L. koolauensis.*

Photo by Alex Lau
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Final Report

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Bishop Museum Technical Report 55
Honolulu, Hawai‘i
October 2011
TABLE OF CONTENTS

EXECUTIVE SUMMARY ................................................................................................................................. iii
I. INTRODUCTION ........................................................................................................................................... 1
   Ia. Setting .................................................................................................................................................. 1
   Ib. Historical Plant Collections of Upper Waikakalua and Kipapa Drainages ................................. 2
   Ic. Past Surveys of O’ahu Forest National Wildlife Refuge ................................................................. 3
   Id. Endangered Species and Critical Habitat Designations ................................................................. 3
II. METHODOLOGY ....................................................................................................................................... 23
III. RESULTS .................................................................................................................................................. 24
   IIIa. Vegetation Zones ............................................................................................................................. 24
       Lowland Wet Forests ......................................................................................................................... 24
           *Metrosideros/Dicranopteris (*Ôhi’a/Uluhe) Fern Forest ............................................................. 24
           *Metrosideros (*Ôhi’a) Lowland Wet Forest ................................................................................. 24
           *Metrosideros/Cheirodendron (*Ôhi’a/Ôlapa) Forest ................................................................. 25
       Lowland Wet Shrublands .................................................................................................................. 25
           *Metrosideros (*Ôhi’a) Lowland Wet Shrubland ................................................................. 25
       Lowland Wet Mixed Communities ............................................................................................... 25
           *Machaerina (*Uki) Mixed Shrub and Sedgeland ........................................................................ 25
           *Ko’olau Prostrate *Metrosideros (*Ôhi’a) Community .................................................. 26
   IIIb. Noteworthy Plant Discoveries/Taxa of Conservation Significance ............................................ 27
   IIIc. Noteworthy Invertebrate Findings ................................................................................................. 31
   IIId. Weedy Plants of Concern ............................................................................................................... 32
IV. RECOMMENDATIONS ............................................................................................................................ 45
V. ACKNOWLEDGMENTS ............................................................................................................................ 46
VI. REFERENCES CITED ............................................................................................................................ 47
VII. SPECIES ACRONYMS USED IN MAP LEGEND ............................................................................. 52
MAP 1. O’ahu Forest NWR Location Map and Survey Coverage ......................................................... 53
MAP 2. Rare Plant Taxa and Survey Routes .............................................................................................. 54
MAP 3. Rare Plant Populations and Communities ................................................................................... 55
MAP 4. Rare and Invasive Plant Taxa Occurrences .................................................................................. 56
APPENDIX A: O’ahu Forest National Wildlife Refuge Vascular Plant Checklist ............................... Appendix A-1
APPENDIX B: Guide to Scientific Name Changes Affecting Plant Taxa Mentioned in this Report .... Appendix B-1
APPENDIX C: Historical Vouchers of Rare and Endangered Plant Taxa Located at Bishop Museum Appendix C-1
APPENDIX D: Historical Vouchers of Non-native Plants Located at Bishop Museum ....................... Appendix D-1
APPENDIX E: Field Identification Cards ............................................................................................... Appendix E-1
EXECUTIVE SUMMARY

Research staff from the Hawaii Biological Survey of Bishop Museum (BISH) conducted a rare plant survey of approximately 220 hectares (540 acres) in the southeastern section of O‘ahu Forest National Wildlife Refuge (OFNWR) for landowner U.S. Fish and Wildlife Service (USFWS), in collaboration with the Ko‘olau Mountains Watershed Partnership (KMWP), the Hawai‘i Invasive Species Council/Weed Risk Assessment, the O‘ahu Invasive Species Committee/O‘ahu Early Detection, and USFWS. The synergistic efforts of researchers from the participating organizations created a capacity-building experience that enriched the knowledge of all participants and provided skills for future collaborations.

The project area lies in the wet central Ko‘olau summit area ranging from 520–825 meters (1,700–2,700 feet) elevation, and is characterized by a series of steep-sided ridges dissected by gulches formed by the headwaters of Waikakalaua and Kipapa Streams, and a portion of Waiawa Stream to the south. Seven days of fieldwork (63 person-days) took place between January and October 2010. The primary objectives of the survey were to explore portions of the designated survey area that had not been visited during recent survey efforts; document new locations of rare and endangered vascular plants; provide an inventory of all vascular plants seen; note major resource concerns (e.g., invasive plant threats, pig damage); create general plant community maps; and provide recommendations for conservation practices. In addition, although not a primary goal of the survey, sightings of endemic *Megalagrion* damselflies and *Achatinella* tree snails were reported.

A total of 165 vascular plant taxa were noted during the survey, including 105 endemic, 14 indigenous, 43 naturalized, and 3 Polynesian-introduced plants. Thus, about 72% of vascular plant taxa seen were native, attesting to the relatively undisturbed nature of the vegetation in the upper elevation wet forest zone of O‘ahu Forest NWR. Six vegetation types were characterized during the 2010 survey, all native-dominated structural variants of lowland wet communities, differing by a combination of elevation, wind exposure, slope, and substrate, and generally dominated by various forms of *Metrosideros polymorpha* (‘öhi‘a), often with the presence of tangled mats of the fern *Dicranopteris linearis* (uluhe).

This report documents rare plant sightings of *Cyanea koolauensis* (Endangered); *Euphorbia rockii* (Endangered); *Labordia hosakana* (Species of Concern); *Lobelia hypoleuca* (Apparently Secure); *L. koolauensis* (Endangered) and/or *L. gaudichaudii* (Species of Concern); *Myrsine fosbergii* (Candidate); *Panicum koolauense* (Species of Concern); *Polyscias gymnocrapa* (Endangered); and *Zanthoxylum oahuense* (Proposed Endangered) during the 2010 survey.

The recent proposal by the U.S. Fish and Wildlife Service to add 23 new taxa of endangered plants to O‘ahu and to redesignate critical habitat for 101 O‘ahu plant taxa is reviewed in terms of its effect on O‘ahu Forest NWR. Forty-four rare and endangered plant taxa have been designated for inclusion in the critical habitat unit in which OFNWR is included. This unit, called Oahu Lowland Wet Unit 9, is an ecologically unified lowland wet ecosystem on the leeward side and summits of the Ko‘olau Mountains extending from Waipi‘o to Manaiki Stream in Kalihi.
The main current biological threat to the integrity of the native plant communities in the upper sections of OFNWR is the spread of invasive plant species. Aside from the very visible invasion of *Leptospermum scoparium* (New Zealand tea tree) along the Kïpapa Trail, at this time the vegetation seems to be relatively unscathed by intractable stands of alien, ecosystem-altering species. Within the upper sections of the valley, the ubiquitous *Clidemia hirta* (Koster’s curse) is the main non-native shrub component on open, disturbed slopes. Most of the herbaceous and grassy weeds are concentrated along trails and on disturbed hilltops. The continued focus of eradication efforts should concentrate on weedy canopy species that are just starting to become established, such as *Psidium cattleianum* (strawberry guava), *Heliocarpus popayanensis* (white moho, occasionally noted), *Schefflera actinophylla* (umbrella tree), *Falcataria moluccana* (albizia), *Spathodea campanulata* (tulip tree, not seen during the 2010 survey), *Citharexylum caudatum* (fiddlewood, not seen during the 2010 survey), *Ardisia elliptica* (shoebutton ardisia), and *Angiopteris evecta* (mule’s-foot fern). A grove of *Cryptomeria japonica* (sugi pine) along the Koʻolau summit should be removed to prevent negative impacts. Many well known invasive species likely to do well in the wet forests of OFNWR lurk outside the perimeters of the refuge and need to be eradicated if seen, such as *Miconia calvescens* and *Tibouchina herbacea*. U.S. Fish and Wildlife Service personnel recently reportedly found and destroyed two vegetative vines of *Passiflora tarminiana* in the refuge; this pervasive weed on Kaua‘i and the Big Island had never before been reported from Oʻahu. One of the keys to managing invasive species impacts is an early detection program that includes monitoring and rapid response to prevent a species from establishing and negatively impacting native ecosystems.

The appendices to this report provide a listing of all plant taxa noted during the 2010 surveys; provide historical vouchered records of rare and endangered plants, as well as alien species, collected in the vicinity of Oʻahu Forest NWR; and displays the output of a pre-survey effort to prepare field cards for both the rare/endangered taxa and invasive alien plants to assist with their identification in the field.
I. INTRODUCTION

A rare plant survey of approximately 220 hectares (540 acres) of O‘ahu Forest National Wildlife Refuge (OFNWR) land was conducted by Bishop Museum (BISH) in the southeastern section of OFNWR for landowner U.S. Fish and Wildlife Service (USFWS), in collaboration with the Ko‘olau Mountains Watershed Partnership (KMWP), the Hawai‘i Invasive Species Council/Weed Risk Assessment, the O‘ahu Invasive Species Committee/O‘ahu Early Detection, and USFWS. The project area lies in the wet central Ko‘olau Mountains summit area between 520 and 825 meters (1,700–2,700 feet) elevation, and is characterized by a series of steep-sided ridges dissected by gulches formed by the headwaters of Waikakalaua and Kïpapa Streams, and a portion of Waiawa Stream to the south. Seven days of fieldwork (63 person-days) took place between January and October 2010. The primary purpose of the survey was to explore portions of the designated survey area that had not been visited during recent survey efforts; document new locations of rare and endangered vascular plants; provide an inventory of all vascular plants seen; note major resource concerns; create general plant community maps; and provide recommendations for conservation practices. In addition, although not a primary goal of the survey, sightings of native *Megalagrion* damselflies and *Achatinella* tree snails were reported.

Ia. Setting

The project area lies in the central leeward Ko‘olau summit area, mauka of Mililani town, and comprises the upper-elevation, southeastern portion of OFNWR, ranging from 520–825 meters (1,700–2,700 feet) elevation, characterized by a series of steep-sided ridges dissected by gulches formed by the headwaters of Waikakalaua and Kïpapa Streams, and a portion of Waiawa Stream to the south (see Map 1, p. 53). The parcel is located within a zone that generally receives 5,000 millimeters (197 inches) or more of rainfall per year; thus, all of the vegetation types are in the “wet” moisture category.

All of the land in the survey area is classified as Rough Mountainous Land (rRT) by Foote et al. (1972). This is the dominant land formation in the upper, wetter leeward Ko‘olau Range. These lands are very steep and are dissected by numerous intermittent drainages. Deep, V-shaped valleys with steep side slopes and narrow ridgelines are the norm. The soil is very thin, ranging from 2.5–25 centimeters (1–10 inches) in thickness over saprolite (thoroughly decomposed, earthy, untransported rock), and not stony. The saprolite is relatively soft and permeable to roots and water. Soil on the ridges is similar to the Amalu (Maui and Moloka‘i) and Olokui (Moloka‘i) series, both poorly drained, wet upland soils. About 20–40% of the land consists of rockland, rock outcrops, soil slips, and eroded spots. In the Hawaiian Islands, rRT lands occur from sea level up to 1,830 meters (6,000 feet) elevation, with rainfall ranging from 180 centimeters (70 inches) to more than 1,000 centimeters (394 inches) per year. Uses for rRT lands include water supply, wildlife habitat,
and recreation. These lands are classified as capability group VIIIe soils, which are subject to severe erosion if the existing vegetation cover is removed. Natural vegetation in the rRT association include *Metrosideros polymorpha* (‘ōhi’a), *Dicranopteris linearis* (uluhe), *Cibotium* spp. (hāpuu), *Setaria parviflora* (yellow foxtail), *Lantana camara* (lantana), *Aleurites moluccana* (kukui), and *Leptecophylla tameiameiae* (pūkiawe).

Edward Y. Hosaka, in conducting ecological and floristic studies in Kīpapa Gulch to partially fulfill requirements for a Master of Science degree at the University of Hawai‘i in the early 1930s, divided the gulch into six broad plant zones (Hosaka 1937). At the extreme seaward end is the Maritime Zone with salt-loving coastal herbs, followed upland by the Haole Koa (*Leucaena leucocephala*), Guava (*Psidium guajava*), and Koa (*Acacia koa*) Zones. Hosaka’s ‘Ōhi’a Zone, which he describes as dominated by tall *Metrosideros polymorpha* trees (reaching maximum height around 550 m elevation), matches large portions of the survey area on lower, protected slopes. He describes associated canopy trees as including ‘ōhi’a hā (*Syzygium sandwicensis*) and ‘ahakea (*Bobea elatior*); second-layer trees including hame (*Antidesma platyphylla*) and kōpiko (*Psychotria mariniana*); shrubs including *Cyrtandra paludosa* and *Cyanea crispa*; the ground layer covered with mosses and ferns; and tree trunks clothed with epiphytic bryophytes and ferns. Finally, Hosaka calls the area above 600 m elevation the Cloud Zone. This very wet zone consists of low, scrubby vegetation in which there are no dominant species. Tree species are dwarfed. Characteristic species include *Metrosideros polymorpha*, ‘ōlapa (*Cheirodendron platyphyllum*), loulu (*Pritchardia martii*), kāmakahala (*Labordia* spp.), na‘ena’e (*Dubautia laxa*), and ‘uki (*Machaerina angustifolia*).

1b. Historical Plant Collections of Upper Waikakalaua and Kipapa Drainages

Many botanists have collected in the upper Waikakalaua–Kipapa drainage during the past century. A search of the Bishop Museum Herbarium database for Hawaiian plant vouchers pulled up numerous botanical collections in the area. A concentrated period of botanical exploration took place during the early 1930s, when Hosaka was spending much field time in the area. BISH holdings include almost 1,500 vouchers from the area, including close to 600 Hosaka vouchers from the Kipapa drainage. Other prominent collections in the 1930s in the Waikakalaua–Kipapa area include those by Edwin H. Bryan, Jr., a Bishop Museum entomologist; F. Raymond Fosberg, then a graduate student at the University of Hawai‘i, later a prominent Pacific botanist at the Smithsonian Institution; Martin L. Grant, a Yale–Bishop Museum fellow; and Harold St. John, prominent Hawaiian botanist. Subsequent botanical vouchers from the region have been spotty, in part due to remoteness and difficulty of access. More recently, Lara Reynolds completed a botanical inventory of the Kipapa Trail portion of O‘ahu Forest National Wildlife Refuge as an undergraduate thesis project at the University of Hawai‘i at Mānoa (Reynolds 2007).

Among vascular plant taxa vouchered during historical collecting trips are the following currently Federally endangered or proposed endangered taxa: *Alectryon macrococcus* (māhoe, Sapindaceae); *Cyanea acuminata*, *C. calycina*, *C. crispa*
O‘ahu Forest National Wildlife Refuge Botanical Survey

C. grimesiana subsp. grimesiana, C. humboldtiana, C. koolauensis, C. lanceolata, C. longiflora, and C. st.-johnii (hāhā, Campanulaceae); Cyrtandra viridiflora (ha‘iwale, Gesneriaceae); Euphorbia (formerly Chamaesyce) rockii (Euphorbiaceae); Gardenia mannii (nā‘ū, Rubiaceae); Hesperomannia arborescens (Asteraceae); Labordia cyrtandrae (kāmakahala, Loganiaceae); Lobelia oahuensis (Campanulaceae); Melicope hiukae and M. lydgatei (alani, Rutaceae); Phylllostegia hirsuta and P. parviflora (Lamiaceae); Platianthera holochila (Orchidaceae); Platylesma cornuta var. cornuta (Rutaceae); Polyscias (formerly Tetraplasandra) gymnocarpa (‘ohe‘ohe, Araliaceae); Psychotria hexandra subsp. oahuensis (köpiko, Rubiaceae); Sanicula purpurea (Apiaceae); Viola oahuensis (Violaceae); and Zanthoxylum oahuense (a‘e, Rutaceae), as well as the rare but unprotected Anoectochilus sandvicensis (Orchidaceae); Cryptocarya mannii (hōlio, Lauraceae); Cyrtandra kalihii (ha‘iwale, Gesneriaceae); Panicum (formerly Dichanthelium) koolauense (Poaceae); Doodia lyonii (Blechnaceae); Eurya sandwicensis (änini, Theaceae); Exocarpos gaudichaudii (hulumoa, Santalaceae); Kadua fluviatilis (Rubiaceae); Joinvillea ascendens (‘ohe, Joinvilleaceae); Labordia hosakana (kāmakahala, Loganiaceae); Liparis hawaiensis (‘awapuhiakanaloa, Orchidaceae); and Lobelia gaudichaudii (Campanulaceae). Appendix C provides a list of representative vouchers of the above taxa stored in the Herbarium Pacificum at Bishop Museum.

1c. Past Surveys of O‘ahu Forest National Wildlife Refuge

In September 2003 the Hawai‘i Natural Heritage Program (now called the Hawai‘i Biodiversity and Mapping Program) conducted a 3-day rare plant survey within a designated 190 hectare parcel of O‘ahu Forest NWR (Hawai‘i Natural Heritage Program 2003). Due to limited field time, the team concentrated on habitats with the best potential for harboring rare taxa. Six rare plant taxa were documented: 1) Euphorbia rockii (Endangered), 15 plants in 2 populations; 2) Cyanea calycina (Proposed Endangered), 5 plants just outside of OFNWR on windward summit slope; 3) Cyanea humboldtiana (Endangered), 4 immatures; 4) Doodia lyonii (Species of Concern), ca. 560 plants; 5) Lobelia oahuensis (Endangered), 4 plants just outside of OFNWR on windward summit slope; and 6) Polyscias gymnocarpa (Endangered), 7 individual sightings. Bishop Museum conducted additional rare plant surveys in May 2005 and May 2006 (Imada & LeGrande 2006a). In addition to relocating some of the populations noted during the 2003 survey, the following rare taxa were documented: 1) an additional population of Euphorbia rockii (8 plants), near gulch bottom south of Kïpapa campsite; 2) Panicum koolauense (Species of Concern), Kïpapa campsite; 3) Gardenia mannii (Endangered), 2 plants, Kïpapa Gulch; 4) Joinvillea ascendens subsp. ascendens (Candidate), 2 clumps, leeward slope of Ko‘olau Summit Trail; 5) Labordia hosakana (Species of Concern), above OFNWR base camp; 6) Lobelia gaudichaudii (Species of Concern); 7) Lobelia koolauensis (Endangered), over 100 plants in vicinity of Kïpapa campsite; and 8) Zanthoxylum oahuense (Proposed Endangered), 2 plants, ridge west of Kïpapa campsite.

Id. Endangered Species and Critical Habitat Designations

In August 2011, the U.S. Fish and Wildlife Service (USFWS) proposed Endangered status and critical habitat for 23 species on O‘ahu, and the designation or redesignation of critical habitat for an additional 101 O‘ahu taxa already listed as endangered or threatened (USFWS 2011a). When critical habitat was designated for 99 O‘ahu plant taxa in 2003
O‘ahu Forest National Wildlife Refuge Botanical Survey

(USFWS 2003), polygons were drawn around discrete areas occupied by each species at the time of listing, resulting in an overlapping and confusing patchwork of critical habitat areas difficult for the public to interpret. The proposed redesignation of critical habitat was based on new information on species distributions and a better understanding of their biological requirements (e.g., elevation, precipitation, substrate, canopy, subcanopy, and understory characteristics), and a new understanding that many native Hawaiian plants and animals currently only occupy areas of marginal habitat primarily because the threats are reduced in those areas, and can thrive when reintroduced into historical habitats when threats are effectively managed. Sixty-six multiple-species critical habitat units were created in the proposed rule, each containing the shared physical or biological features essential for the conservation of those individual species occupying that particular unit, or containing suitable essential habitat for the conservation of species suited for, but not presently occurring in, that unit (USFWS 2011a).

Lands of the O‘ahu Forest National Wildlife Refuge are contained within proposed critical habitat area Oahu–Lowland Wet–Unit 9, comprising 6,365 hectares (15,728 acres) in the lowland wet ecosystem on the leeward side of the Ko‘olau Mountains, on Federal (U.S. Fish and Wildlife Service), State, City and County of Honolulu, and privately-owned land, extending along the Ko‘olau summit from Waipi‘o to Manaiki Stream in Kalihi. This unit includes the wet forest and shrubland, moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the lowland wet ecosystem, as well as unique primary constituent elements for Hawaiian damselflies. For purposes of their ecosystem classification scheme, the USFWS defined the Lowland Wet ecosystem as including a variety of wet grasslands, shrublands, and forests high in biological diversity, generally occurring below 1,000 meters (3,300 feet) elevation on the windward sides of the main Hawaiian Islands (except Kaho‘olawe and Ni‘ihau), and receiving more than 190 centimeters (75 inches) annual precipitation. On O‘ahu, this system is best developed in wet valleys and slopes along the summit of the Ko‘olau Mountains, with a small area located on the windward side of the summit of the Wai‘anae Mountains (USFWS 2011a).

Because the streams and upland foraging and cover areas required by the damselflies are dispersed in the lowland wet ecosystem, the physical or biological features of this habitat type are essential to the damselfly species, as they provide for the proper ecological functioning of this ecosystem. Fourty-four plant taxa (32 Endangered, 12 Proposed Endangered) have critical habitat in this unit; of these, 20 taxa are already present in the unit, and for 24 taxa it serves as unoccupied habitat (USFWS 2011a). Unoccupied habitat is essential for the conservation of these species by providing the primary constituent elements necessary for the reestablishment of wild populations within their historical ranges, and for providing suitable areas for recovery in case of catastrophic random naturally occurring events at one or more locations where the species occurs. Due to their small numbers of individuals or low population sizes, these species require suitable additional habitat and space for expansion or reintroduction to achieve population levels that will promote their recovery (USFWS 2011a).

Oahu–Lowland Wet–Unit 9 is occupied habitat for 16 Endangered (Cyanea humboldtiana, C. koolauensis, C. st.-johnii,

The ultimate goal of the USFWS in designating critical habitat for each endangered species is to provide sufficient protected habitat to allow the species to reach benchmark levels to become stabilized, downlisted, and ultimately delisted from the Federal Endangered list. The objectives at each level are as follows (USFWS 1999):

- **Stabilization**: managed to control threats (e.g., fencing, weeding, etc.) and represented in an *ex situ* collection. A minimum of 3 populations should be documented on islands where they now occur or occurred historically. Each population must be naturally reproducing and increasing in number, with the following minimum numbers of mature individuals: 25 for long-lived perennials, 50 for short-lived perennials, 100 for annuals.

- **Downlisting**: a total of 5–7 populations of each taxon should be documented on islands where they now occur or occurred historically. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, 500 for annuals. Each population should persist at this level for a minimum of 5 consecutive years before downlisting can be considered.

- **Delisting**: a total of 8–10 populations of each taxon should be documented on islands where they now occur or occurred historically. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for annuals. Each population should persist at this level for a minimum of 5 consecutive years.

Short profiles are provided below for each of the 43 endangered plant species (Plantago princeps is represented by two varieties) for which Oahu Lowland Wet Unit 9 provides occupied or unoccupied habitat.

- **Adenophorus periens** (palai lā‘au, Grammitidaceae, Endangered) is an epiphytic, pendent fern with deeply pinnatifid fronds 10–40+ centimeters long, the upper lobe margins nearly perpendicular to the midrib, and the lobes displayed at an angle that create a venetian-blind effect (Palmer 2003). It is still found on Kaua‘i,
Moloka‘i, and Hawai‘i, but is considered extinct on O‘ahu and Lāna‘i; on O‘ahu, it was last observed in the early 1900s in the Ko‘olau Mountains (USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat for *A. periens* (USFWS 2011a). There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR.

- **Cyanea acuminata** (hāhā, Campanulaceae, Endangered) is a herb up to 2 meters tall, woody at the base, with thin, oblanceolate to narrowly obovate or elliptic leaves 11–32 centimeters long, and white corollas (sometimes tinged purple) 30–35 millimeters long (Wagner et al. 1990). It is endemic to the northern to central Ko‘olau and Wai‘anae Mountains of O‘ahu, on slopes, ridges, or streambanks in *Metrosideros-Dicranopteris* (‘ōhi‘a-uluhe) or *Metrosideros-Acacia* (‘ōhi‘a-koa) wet or mesic forest or shrubland, or *Diospyros-Metrosideros* (lama-‘ōhi‘a) lowland mesic forest (USFWS 2003, 2009a). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 15 occurrences totaling between 149 and 175 individuals. The U.S. Army Garrison (2010) reported 182 adults and 67 immatures, with the biggest population in the Wai‘anaes (103 adult, 43 immature), while in the Ko‘olau to the north of O‘ahu Forest NWR, populations were found in Kaluanui–Ma‘akua (13 adult, 8 immature); Kaipāpa‘u–Koloa (1 adult); Helemano to Punalu‘u summit ridge to North Kaukonahua (59 adult, 13 immature); South Kaukonahua (2 adult); and Kahana–Makaua (11 adult, 3 immature). To the south, while populations at Kōnāhuanui, Pia, and Pu‘u o Kona are reportedly gone, at last report there were 3 mature plants still at Pu‘u Keahiakahoe (U.S. Army Garrison 2010). Oahu Lowland Wet Unit 9 is considered unoccupied habitat (USFWS 2011a) for *C. acuminata*. Bishop Museum vouchers (see Appendix C) record the historic presence of *C. acuminata* inside O‘ahu Forest NWR boundaries, but no recent sightings have been documented.

- **Cyanea calycina** (hāhā, Campanulaceae, Proposed Endangered) is an unbranched shrub up to 3 meters tall with prickly young stems and leaves, the corolla usually magenta or rarely pale greenish; it is distinguishable from similar species (*C. crispa, C. humboldtiana, C. lanceolata*) by the presence of branched and clustered hairs on the leaf undersurfaces (simple hairs in the other species) (Wagner et al. 1990). In Wagner et al. (1990), this species was known as *Rollandia lanceolata* subsp. *calycina*. *Cyanea calycina* is endemic in both the Wai‘anae and Ko‘olau Mountains of O‘ahu in lowland mesic to wet and montane wet forests and wet cliff habitats (USFWS 2011a). In the Ko‘olau Mountains it was known historically along the entire length of the range in wet *Metrosideros-Dicranopteris* forest and shrubland at elevations between 558 and 900 meters (1,830 and 3,000 feet) (USFWS 2011a), and is currently known from 22 occurrences totaling between 155 and 169 individuals along the summit ridges, ranging in the north from Kamananui Gulch to the south at Kōnāhuanui. Combined with the Wai‘anae totals, there are 40 occurrences totaling 325–339 individuals (USFWS 2011a). Bishop Museum vouchers (see Appendix C) record the historic presence of *C. calycina* inside O‘ahu Forest NWR boundaries, and a population of 5 plants was noted during the Hawai‘i Natural Heritage Program (2003) survey of the refuge.

- **Cyanea crispa** (hāhā, Campanulaceae, Endangered) is an unbranched shrub vegetatively distinctive for its broadly obovate, 30–75 centimeter long leaves (Wagner et al. 1990). In Wagner et al. (1990), this species was
known as *Rollandia crispa*. *Cyanea crispa* is endemic to lowland mesic to wet forests and wet cliff habitats in the Koʻolau Mountains of Oʻahu, and is currently reported from 7 occurrences totaling 56 individuals (USFWS 2011a). The U.S. Army Garrison (2010) reported 15 remaining adults and 14 immatures at Kawai Iki (2 adult, 4 immature), Kaipāʻu (2 immature), and Kahana–Makaua (7 adult, 7 immature) to the north of Oʻahu Forest NWR; and ʻAihualama (1 mature) and Wailupe (5 adult, 1 immature) to the south. Oahu Lowland Wet Unit 9 is considered unoccupied habitat (USFWS 2011a) for *C. crispa*. Bishop Museum vouchers (see Appendix C) record the historic presence of *C. crispa* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented.

- **Cyanea grimesiana** subsp. *grimesiana* (hāhā, Campanulaceae, Endangered) is an unbranched to sparingly branched shrub distinctive for its irregularly pinnately divided, 27–58 centimeter long leaves, described by Wagner et al. (1990) as occurring on Oʻahu, Molokaʻi, Lānaʻi, and Maui. Lammers (1998) subsequently resurrected and raised to species level two synonymized varieties (*C. grimesiana* vars. *mauiensis* and *munroi*), which are now recognized as *C. mauiensis* (from Maui) and *C. munroi* (from Molokaʻi and Lānaʻi). Thus, the current range of *C. grimesiana* subsp. *grimesiana* is Oʻahu and Molokaʻi (Lammers 1998). Currently, there are reportedly five to six individuals in four occurrences in lowland mesic to wet habitats in the Waiʻanae and Koʻolau Mountains (USFWS 2011a), although USFWS (2010a) reports that the taxon is apparently extinct in the wild in the Koʻolau Mountains. Once widely distributed throughout the Koʻolau Mountains (Bishop Museum Herbarium database, accessed 2011), it has recently only been reported in the southeastern Koʻolau. Two populations in Kuluʻi Gulch had declined to a single individual when observed in 1994; a single dying individual was observed in 2004 at Pia Gulch at 616 meters (2,020 feet) elevation; and three individuals were noted in 1985 in Waiʻalae Iki–Kapakahī (USFWS 2011b). Oahu Lowland Wet Unit 9 is considered unoccupied habitat (USFWS 2011a) for *C. grimesiana* subsp. *grimesiana*. Bishop Museum vouchers (see Appendix C) record the historic presence of *C. grimesiana* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented. Three of six *C. grimesiana* subsp. *grimesiana* outplanted at the Kupaua exclosure in the southeastern Koʻolau were still surviving in 2009 (Plant Extinction Prevention Program 2010).

- **Cyanea humboldtiana** (hāhā, Campanulaceae, Endangered) is an unbranched shrub 1–2 meters tall that, when fertile, can be distinguished from the similar *C. calycina*, *C. crispa*, and *C. lanceolata* by its pendent racemes of dark magenta (rarely white) flowers on long peduncles 8–25 centimeters long (Wagner et al. 1990). In Wagner et al. (1990), this species was known as *Rollandia humboldtiana*. *Cyanea humboldtiana* is endemic to lowland wet and wet cliff habitats in the Koʻolau Mountains of Oʻahu, and there are currently 9 occurrences totaling between 160 and 260 individuals (USFWS 2011a), primarily in the southern half of the Koʻolau (Puʻu Keahiakawehi, Kōnāhuanui, Wailupe–Pia, but ranging north to Kaluanui, Maʻakua, ʻOpaeʻula, and Poamoho (USFWS 2010a). Bishop Museum vouchers (see Appendix C) record the historic presence of *C. humboldtiana* inside Oʻahu Forest NWR boundaries, and a population of four immature plants was noted during the Hawaiʻi Natural Heritage Program (2003) survey of the refuge.
**Cyanea koolauensis** (hähä, Campanulaceae, Endangered) is an unbranched shrub with linear to narrowly elliptic leaves 16–36 centimeters long, 1.5–4 centimeters wide, whitish green on the underside; and 3–6-flowered axillary racemes of dark magenta flowers (Wagner et al. 1990). This species was known as *Rollandia angustifolia* in Wagner et al. (1990); when the genus *Rollandia* was merged into *Cyanea* (Lammers 1993), the name *Cyanea angustifolia* had already been published for a different species, so Lammers gave it a new specific epithet, *koolauensis*. *Cyanea koolauensis* occurs in lowland wet habitats on slopes, stream banks, and ridge crests in wet *Metrosideros-Dicranopteris* forest or shrubland at elevations between 163 and 959 meters (535 and 3,146 feet) in the Ko‘olau Mountains of O‘ahu (USFWS 2003). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 15 occurrences with approximately 100 individuals, primarily in the northern Ko‘olau. The latest rare plant stabilization census by the U.S. Army Garrison (2010) reported 9 population units totaling 110 adult and 33 immature plants, with a concentration in the Kaipāpā‘u–Koloa–Kawaiui area (55 adult, 16 immature), Kaukonahua (14 adult, 2 immature), ‘Ōpae‘ula–Helemano (13 adult, 8 immature), Poamoho (12 adult), and smaller populations in Kamananui–Kawaiui Ridge, Kawai Iki, and lower ‘Ōpae‘ula north of OFNWR; to the south, there are only scattered recent sightings from Waiawa–Waimano (3 adult) and Wailupe (1 adult). It has been observed in flower and fruit during the months of May through August (USFWS 2003). Bishop Museum vouchers (see Appendix C) record the historic presence of *C. koolauensis* inside O‘ahu Forest NWR boundaries. During the October 2010 survey, five healthy mature, vegetative plants were noted (see Map 2, p. 54) just off the crest of a flattened ridge at 725 meters (2,380 feet) elevation, where they grew in the company of a single individual of the endangered *Polyscias gymnocarpa* (‘ohe‘ohe), *Machaerina angustifolia* (‘uki), *Sadleria pallida* (‘ama‘u ‘i‘i), and *Wikstroemia oahuensis* (‘äkia). The primary threat at this site is potential competition with weeds.

**Cyanea lanceolata** (hähä, Campanulaceae, Proposed Endangered) is an unbranched 3 meter tall shrub endemic to the Ko‘olau Mountains in lowland mesic and wet habitats at elevations between 300 and 760 meters (1,000 and 2,500 feet) (USFWS 2011a). In Wagner et al. (1990), this species was known as *Rollandia lanceolata*. It is closely related to *Cyanea calycina* (once considered a subspecies of *C. lanceolata*), but differs in having triangular calyx lobes (versus rounded or truncate in *C. calycina*) and simple hairs on the lower leaf surface (versus branched and clustered in *C. calycina*) (Wagner et al. 1990). Historically wide-ranging along the Ko‘olau Mountains, today there are 7 known occurrences totaling fewer than 123 individuals, sparsely scattered over a much smaller area of the northern (Kawai Iki Stream, Poamoho, Pe‘a‘hinai‘a) and southern Ko‘olau (Kulu‘i–Hawai‘i Loa, Wailupe, Mau‘umae, Wai‘alae Nui, and possibly Pia Valley (USFWS 2011a). Oahu Lowland Wet Unit 9 is considered unoccupied habitat (USFWS 2011a) for *C. lanceolata*. Bishop Museum vouchers (see Appendix C) record the historic presence of *C. lanceolata* inside O‘ahu Forest NWR boundaries.

Fig. 2. Joel Lau with *Cyanea koolauensis*. 
• **Cyanea purpurellifolia** (hāhā, Campanulaceae, Proposed Endangered) is an unbranched shrub up to 0.5 meters tall with narrowly oblong to spatulate leaves 12–35 centimeters long, the lower surface purple (Wagner et al. 1990). In Wagner et al. (1990), this species was known as *Rollandia purpurellifolia*. *Cyanea purpurellifolia* is endemic to the Koʻolau Mountains in lowland wet and wet cliff habitats at elevations between 570 and 660 meters (1,860 and 2,160 feet) (USFWS 2011a). Historically, this species was known from a few individuals in the vicinity of Kaluanui Valley and north to Maʻakua–Papali Ridge, and is currently extant in the northern Koʻolau Mountains from Maʻakua–Kaipapaʻu to Punaluʻu–Kaluanui Ridge in 5 occurrences with approximately 18 individuals (USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. purpurellifolia*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of Oʻahu Forest NWR.

• **Cyanea st.-johnii** (hāhā, Campanulaceae, Endangered) is an unbranched shrub up to 0.6 meters tall; the leaves are narrow, lanceolate to oblanceolate, 6–13 centimeters long, strongly revolute, the upper surface with deeply impressed venation; the flowers are white, suffused with pale violet, 3–6 centimeters long (Wagner et al. 1990). In Wagner et al. (1990), this species was known as *Rollandia st.-johnii*. *Cyanea st.-johnii* is endemic to the central Koʻolau summit ridge and wet windswept slopes and ridges in *Metrosideros* (ʻōhiʻa) mixed lowland shrubland or *Metrosideros-Dicranopteris* (ʻōhiʻa-uluhe) lowland shrubland (USFWS 2003). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 6 occurrences with approximately 70 individuals in the Koʻolau. The U.S. Army Garrison (2010) reported 48 remaining adults and 16 immatures along the Koʻolau summit, both to the north (Helemano: 4 adult, 1 immature) and mostly to the south (Waiāhole–Waiawa: 6 adult, 3 immature; Waimano: 14 adult, 5 immature; Waiheʻe–Waimalu: 10 adult; ʻĀhuimanu–Hālawa: 8 adult, 3 immature; and Waimānalo–Waiulupe: 6 adult, 4 immature) of Oʻahu Forest NWR. Bishop Museum vouchers (see Appendix C) record the historic presence of *C. st.-johnii* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented.

• **Cyanea truncata** (hāhā, Campanulaceae, Endangered) is an unbranched shrub up to 2 meters tall with prickly stems; obovate leaves 22–60 centimeters long, 10–26 centimeters wide; inflorescence peduncle plus rachis 4–28 centimeters long; and flowers white, suffused with magenta, 32–42 millimeters long (Wagner et al. 1990). It is endemic to lowland mesic to wet forests and wet cliff habitats in the Koʻolau Mountains of Oʻahu (USFWS 2011a). Currently, there are 2 known wild individuals in Kahana Valley, along with outplanted occurrences (Kahana, Makaua, Hakipuʻu) totaling 14 individuals (Plant Extinction Prevention Program 2008; USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. truncata*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of Oʻahu Forest NWR.

• **Cyrtandra dentata** (haʻiwale, Gesneriaceae) is a shrub up to 5 meters tall with opposite, broadly elliptic to suborbicular or broadly ovate to ovate leaves 9–33 centimeters long, both surfaces hairy; flowers 3–9 in axillary cymes, hairy throughout; peduncles 25–50 millimeters long; and calyces nearly actinomorphic, lobes narrowly...
lanceolate, cleft nearly to the base (Wagner et al. 1990). It is endemic to lowland mesic and wet habitats in both the Wai‘anae and Ko‘olau Mountains, O‘ahu, as well as dry cliff habitats in the Wai‘anaes (USFWS 2011a). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 6 occurrences totaling approximately 1,640 individuals islandwide, largely concentrated in the Wai‘anaes; Ko‘olau populations are found in the leeward northern end at Kawai Iki (15 adult, 31 immature) and ‘Ōpae‘ula (16 adult, 12 immature) (U.S. Army Garrison 2010). Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. dentata*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR.

**Cyrtandra gracilis** (ha‘iwale, Gesneriaceae, Proposed Endangered) is an endemic shrub with opposite, elliptic-ovate, 11.5–22 centimeter long leaves, the apex long-acuminate, base attenuate, both surfaces sparsely covered with white, hemispherical glands; flowers 1–7 in open, axillary cymes on peduncles 8–22 centimeters long; and the calyces nearly actinomorphic, with linear lobes cleft to the base (Wagner et al. 1990). *Cyrtandra gracilis* is found in lowland wet *Metrosideros-Dicranopteris* habitats in the leeward southern Ko‘olau Mountains at about 490 meters (1,600 feet) elevation (USFWS 2011a). Presumed extinct at historical locations in Pālolo Valley, Kōnāhuanui Gulch, and Mānoa Valley, 10 plants were rediscovered in Pia Valley in 2001 (USFWS 2011a). By 2009, only four plants were still surviving (Plant Extinction Prevention Program 2010). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. gracilis*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR.

**Cyrtandra kaulantha** (ha‘iwale, Gesneriaceae, Proposed Endangered) is a shrub with horizontal stems, from which arise erect, usually unbranched shoots up to 3 meters tall; clustered, opposite, sessile, oblanceolate to elliptic-oblancoate, 30–60 centimeter long leaves forming rosettes on the upper 3–6 nodes; and flowers with zygomorphic calyces produced in dense compound cymes along the lower third of the stem and at the base or even on adventitious roots (Wagner et al. 1990). *Cyrtandra kaulantha* is endemic to lowland wet and wet cliff habitats in the windward Ko‘olau Mountains at elevations between 255 and 320 meters (840 and 1,050 feet) (USFWS 2011a). Historically it has been known from dense shade in moist wooded gulches in the Waiähole–Waikäne drainage and at Kahanaiki Stream. Currently, there are 5 occurrences totaling 28 wild and 12 outplanted individuals (USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. kaulantha*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR.

**Cyrtandra polyantha** (ha‘iwale, Gesneriaceae, Endangered) is a shrub up to 3 meters tall with opposite, elliptic, 5–16 centimeter long leaves, the upper surface conspicuously rugose, the margins often revolute; flowers 7–12 in axillary cymes on peduncles 12–18 millimeters long; and calyces nearly actinomorphic, cleft at least halfway, the lobes narrowly triangular (Wagner et al. 1990). *Cyrtandra polyantha* is endemic to the southeastern Ko‘olau Mountains of O‘ahu. Currently, there are two occurrences of 7–9 individuals in lowland mesic and wet habitats on Kulepeamoa Ridge and the summit of Kuliʻouʻou (USFWS 2009b, 2011a); in 2008, there were reportedly 46 mature individuals in the 2 populations (Plant Extinction Prevention Program 2008).
O’ahu Forest National Wildlife Refuge Botanical Survey

Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. polyantha*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O’ahu Forest NWR.

- **Cyrtandra sessilis** (ha‘iwale, Gesneriaceae, Proposed Endangered) is a small shrub up to 1 meter tall with sessile, oblanceolate, mostly glabrous leaves 8–20 centimeters long, in well spaced whorls of 3 per node; and 3–8-flowered cymose, axillary inflorescences with white flowers and zygomorphic calyces (Wagner et al. 1990). It is endemic to the Koʻolau Mountains, typically found in lowland wet *Metrosideros* forests in wet gulch bottoms, slopes of mesic valleys, and wet cliff habitats at elevations between 490 and 670 meters (1,600 and 2,200 feet) (USFWS 2011a). The species is currently known from 2 occurrences: along the Waikåne–Schofield Trail in Kahana Valley (75 adult, 15 immature); and the Hawaiʻi Loa Ridge near Pia Valley (5 adult) (Plant Extinction Prevention Program 2008; USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. sessilis*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O’ahu Forest NWR.

- **Cyrtandra subumbellata** (ha‘iwale, Gesneriaceae, Endangered) is a shrub up to 3 meters tall with opposite, suborbicular to ovate leaves constricted to a decurrent base, 12–39 centimeters long, the upper surface impressed rugose, glabrous, the lower surface with white hemispherical glands; and dense, axillary, cymose, 5–15-flowered inflorescences, the calyx lobes linear, cleft nearly to the base, actinomorphic (Wagner et al. 1990). It is endemic to lowland wet and wet cliff habitats in the north-central Koʻolau Mountains of O’ahu (USFWS 2011a). Currently, the U.S. Fish and Wildlife Service (2011a) reports 3 occurrences totaling 100+ individuals; the U.S. Army Garrison (2010) reported 218 plants (211 adult, 7 immature) from Kahana (8 adult, 7 immature), Punalu’u (201 adult), and Uwao (2 adult), with a small population in Kaukonahua reportedly dead. Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *C. subumbellata*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O’ahu Forest NWR.

- **Cyrtandra viridiflora** (ha‘iwale, Gesneriaceae, Endangered) is a small shrub up to 2 meters tall with few opposite, thick and fleshy, cordate leaves 6–15 centimeters long, densely velvety on both surfaces; and densely velvety, 1–5-flowered axillary cymes with greenish flowers, the calyx lobes actinomorphic, cleft only partway to the base, the lobes lanceolate (Wagner et al. 1990). It is endemic to the north-central Koʻolau Mountains, found in lowland wet and wet cliff habitats on moist slopes and gulch bottoms in *Metrosideros* wet forest or mixed with *Dicranopteris* and *Acacia koa* (USFWS 2011a). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 5 occurrences totaling 75 individuals. The U.S. Army Garrison (2010) reported 57 remaining adults and 17 immatures ranging from Helemano–ʻŌpae‘ula (39 adult, 13 immature), Kawaihui–Koloa (16 adult, 4 immature), and South Kaukonahua to Kipapa summit (2 adult). Bishop Museum vouchers (see Appendix C) record the historic presence of *C. viridiflora* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented.

- **Cyrtandra waiolani** (ha‘iwale, Gesneriaceae, Proposed Endangered) is a small shrub up to 2 meters tall with opposite, elliptic, moderately hairy leaves 5–16 centimeters long, the petioles 1.3–5 centimeters long, shaggy
hairy; and 1–2-flowered inflorescences, densely brown hairy throughout, the calyx lobes actinomorphic, linear to oblong-lanceolate, cleft to the base, and densely brown hairy (Wagner et al. 1990). *Cyrtandra waiolani* is endemic to the Ko’olau Mountains, historically found in rich, partly sunny gulches; shady, moist banks above creeks; and wet gulch bottoms in mesic valleys in lowland mesic and wet habitats (USFWS 2011a), ranging from Kaipāpā’u and Punalu’u north of O’ahu Forest NWR, to Kalihi Valley in the southern Ko’olau’s, at elevations between 240 and 900 meters (800 and 3,000 feet) (Bishop Museum Herbarium database, accessed 2011; USFS 2011a). More recently, vegetative individuals likely representing *C. waiolani* were seen in 1994 along the ridge between Kaipapa’u and Ma’akua, and in 2005 in Kahana and on Kualono Ridge near Ka’a’awa, but only the Kualono Ridge plant continues to survive (USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFS 2011a) for *C. waiolani*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O’ahu Forest NWR.

- **Euphorbia rockii** (‘akoko, Euphorbiaceae, Endangered) is a compact shrub or small tree up to 2 meters tall, with milky sap; leathery, narrowly oblong to elliptic leaves arranged in a single plane along the stems, 8–14 centimeters long; and bright red, globose, erect capsules 14–25 millimeters long (Wagner et al. 1990); fruiting has been observed in February (USFS 2003). In Wagner et al. (1990), this species was known as *Chamaesyce rockii*; however, recent molecular studies have shown that the genus *Chamaesyce* is nested within the large genus *Euphorbia* (Bruyns 2006), and all recognized *Chamaesyce* taxa have been transferred to *Euphorbia* (The Plant List 2011, accessed September 2011). *Euphorbia rockii* is endemic to lowland wet and wet cliff habitats in the Ko’olau Mountains of O’ahu, on gulch slopes and bottoms, and ridge crests in wet *Metrosideros-Dicranopteris* forest and shrubland (USFS 2003, 2011a). Currently, the U.S. Fish and Wildlife Service (USFS 2011a) reports 6 occurrences with 576–710 individuals. The U.S. Army Garrison (2010) estimated only 121 adult and 18 immature individuals from Helemano (7 adult, 1 immature), Kawai Iki (48 adult, 2 immature), Kawainui to Koloa and Kaipāpā’u (37 adult, 13 immature), Kaukonahua to Kipapa (14 adult, 2 immature), and Waiawa to Waimano (15 adult). Bishop Museum vouchers (see Appendix C) record the historic presence of *E. rockii* inside O’ahu Forest NWR boundaries, and it has been noted during recent surveys of the refuge by the Hawai’i Natural Heritage Program (2003) (15 plants) and Imada and LeGrande (2006a) (8 plants). During the January 2010 survey, a single healthy immature plant 25 centimeters tall was noted (see Map 2, p. 54) at 765 meters (2,515 feet) elevation north and downslope from the Lobelia Bog campsite, on a northern exposure, where it grew on an open, saturated, almost canopyless 45–70% slope dominated by the sedge *Machaerina angustifolia* (‘uki), with scattered *Sadleria pallida* (‘ama’u ‘i’i) and *Wikstroemia oahuensis* (‘ākia). The primary threat at this site is competition with weeds; pig damage was not noted anywhere in the vicinity. Also, a mature hybrid specimen
between *Euphorbia rockii* and the closely allied *E. clusiifolia* grows on the margin of the helicopter landing zone at the Kipapa Manuka platform (see Map 2).

- **Gardenia mannii** (nāʻū, Rubiaceae, Endangered) is a tree 5–15 meters tall with viscid, oblanceolate leaves 6–27 centimeters long, clustered toward the branch tips; cuplike interpetiolar stipules; solitary white, 7–9-lobed flowers; and calyces with 4–6 elongated, linear-spatulate spurs 30–46 millimeters long (Wagner et al. 1990). It is endemic to Oʻahu, mainly in the Koʻolau Mountains on gulch slopes and bottoms, streambanks, ridge crests, and leeward drainages in lowland mesic to wet habitats, with a small population in the Waiʻanaes (USFWS 2003). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 18 occurrences totaling 108–110 individuals. The U.S. Army Garrison (2010) reported 85 remaining adults and 1 immature plant, all but 4 plants in the Koʻolau Range north of Oʻahu Forest NWR, primarily from Kaiwikōʻele–Kamananui–Kawainui (20 adult), Helemano–Poamoho (14 adult), Peʻahināʻa (37 adult, 1 immature), and ʻŌpaeʻula (8 adult). In Oahu Lowland Wet Unit 9, it has been recently documented in Hālawa (C. Imada, pers. comm., 2011), Kalauao (Imada & LeGrande 2006b), Pūkele, and Kapakahí (U.S. Army Garrison 2010; USFWS 2010a). Bishop Museum vouchers (see Appendix C) record the historic presence of *G. mannii* inside Oʻahu Forest NWR boundaries, and two plants were noted during the 2005–2006 Bishop Museum survey of the refuge (Imada & LeGrande 2006a).

- **Hesperomannia arborescens** (no common name, Asteraceae, Endangered) is a shrubby tree up to 5 meters tall with usually lanceolate to oblanceolate leaves 10–20 centimeters long; the flowers are in thistlelike heads, solitary or 2–10, 5–7 centimeters long, the corolla yellow, the pappus bristles yellowish brown or tinged purple (Wagner et al. 1990). It is historically known from Oʻahu, Molokaʻi, Lānaʻi, and Maui. On Oʻahu it occurs largely in the Koʻolau Mountains, where it is found in lowland mesic and wet habitats (USFWS 2011a). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 19 occurrences totaling approximately 130 individuals, now restricted largely to the northern Koʻolau. The U.S. Army Garrison (2010) reported 163 remaining adults and 125 immatures from Kamananui–Kaluanui (56 adult, 46 immature), ʻŌpaeʻula (9 adult, 15 immature), Kaukonahua (76 adult, 56 immature), and Poamoho (22 adult, 8 immature); historic populations to the south of Oʻahu Forest NWR at Waimano, Hālawa, Kapakahí, and Niu–Waimanalo summit ridge have not been seen recently (U.S. Army Garrison 2010). Bishop Museum vouchers (see Appendix C) record the historic presence of *H. arborescens* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented.

- **Huperzia nutans** (no common name, Lycopodiaceae, Endangered) is an erect or pendent, terrestrial or epiphytic lycopod restricted to Kauaʻi and Oʻahu on open ridges, forested slopes, or cliffs in *Metrosideros* (ʻōhiʻa)-dominated wet forest or shrubland, or mesic forest (USFWS 2003). It differs from the common *H. phyllanthum* in having sterile leaves arranged in 6 rows (versus irregular rows in *H. phyllanthum*); and a much wider, unbranched or once-branched fertile portion, gradually transitional from the sterile stem (versus a narrow, many-branched fertile portion abruptly transitional from the sterile stem in *H. phyllanthum*) (Palmer
This species has alternatively in the past been called *Lycopodium nutans* or *Phlegmariurus nutans* (Palmer 2003). Currently on O‘ahu the U.S. Fish and Wildlife Service (USFWS 2011a) reports 2 occurrences totaling between 10–15 individuals in the lowland wet and wet cliff ecosystems in the north to central Ko‘olau Mountains. The U.S. Army Garrison (2010) reported 9 remaining adults and 2 immatures north of O‘ahu Forest NWR at Kahana–North Kaukonahua (5 adult), South Kaukonahua (1 adult), and Kaipāpa‘u–Koloa (3 adult, 2 immature). Oahu Lowland Wet Unit 9 is unoccupied habitat for *H. nutans* (USFWS 2011a). There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR.

- **Isodendrion longifolium** (aupaka, Violaceae, Endangered) is a few-branched shrub up to 2 meters tall with alternate, oblanceolate leaves 10–30 centimeters long, the base attenuate, the venation strongly reticulate and raised; the flowers are solitary, axillary, with 5 purple petals (Wagner et al. 1990). It is endemic to Kaua‘i and O‘ahu, occurring on steep slopes or streambanks in mixed mesic or lowland wet *Metrosideros-Dicranopteris* (*‘ōhi‘a-uluhe*) forest (USFWS 2003). Currently, on O‘ahu there are 4 occurrences totaling between 32 and 36 individuals in the Wai‘anae and Ko‘olau Mountains (USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *I. longifolium*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR, but the species has been documented from Makaua Valley, Ka‘a‘awa Gulch, and Kaukonahua Stream (USFWS 2011c).

- **Labordia cyrtandrae** (kāmakahala, Loganiaceae, Endangered) is a shrub up to 2 meters tall with opposite, obovate to broadly elliptic leaves 15–30 centimeters long, dark green above, pale green below, crowded at the branch ends; cuplike interpetiolar stipules; and terminal, 8–80-flowered inflorescences, the corolla pale greenish yellow to pale yellow, 20–35 millimeters long (Wagner et al. 1990). It is endemic to lowland mesic to wet and montane wet forests and wet cliff habitats in the Wai‘anae and Ko‘olau Mountains of O‘ahu (USFWS 2011a). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 3 occurrences totaling 44 individuals in the Wai‘anae Mountains, and a single individual in lowland wet habitat in Mānana in the Ko‘olau Mountains. Bishop Museum vouchers (see Appendix C) record the historic presence of *L. cyrtandrae* inside O‘ahu Forest NWR boundaries, but no recent sightings have been documented.

- **Lobelia koolauensis** (no common name, Campanulaceae, Endangered) is an unbranched shrub up to 2.5 meters tall, the stout stem up to 3 centimeters in diameter, with a dense apical rosette of sessile, linear to oblanceolate or elliptic leaves 12–20 centimeters long, the margins revolute; the terminal inflorescence is up to 2 meters tall, 2–7-branched, with white flowers (Lammers 2007). *Lobelia koolauensis* is endemic to the north to central Ko‘olau Mountains on moderate to steep slopes in *Metrosideros* lowland wet shrubland or bog (USFWS 2003), ranging from Pu‘u Ka‘inanapua‘a to ‘Eleao (Lammers 2007). Up until recently, *L. koolauensis* was considered a variant of *L. gaudichaudii* (*L. gaudichaudii* subsp. *koolauensis*), differing from subsp. *gaudichaudii* in part by its white flowers and branching inflorescences (versus red flowers and unbranched inflorescences in subsp. *gaudichaudii*) (Wagner et al. 1990). The two subspecies had different geographic ranges—subsp. *koolauensis*
concentrated in the northern Koʻolau, subsp. gaudichaudii in the southern Koʻolau—but with an overlap in distribution in the central Koʻolau between Puʻu Pauao and ‘Eleao (within which Oʻahu Forest NWR is nestled) (U.S. Army Garrison 2007; Lammers 2007; USFWS 2009c). Noting that, despite this overlap, there appeared to be no intermediate hybrid forms in this zone, Lammers (2007) reasoned that the taxa were probably reproductively isolated (suggested by the difference in flower color and anther length between the two taxa) and elevated subsp. koolauensis to full species.

Vegetative specimens are problematical in the refuge; are they the federally listed Endangered species (*L. koolauensis*) or the species with no federal protection (*L. gaudichaudii*)? There is apparently no suite of vegetative characters that can consistently distinguish between the two. Lammers (2007) noted that the leaves of *L. koolauensis* were “glabrous or the abaxial midrib pubescent,” while *L. gaudichaudii* was “densely long pubescent on the abaxial midrib (rarely glabrous).” Voucher specimens at Bishop Museum (BISH) appear to confirm it, with many *L. gaudichaudii* specimens obviously shaggy hairy on the abaxial midrib, but some specimens glabrous; meanwhile, none of the *L. koolauensis* at BISH were hairy. The herbarium observation needs to be field-tested against identifiable flowering plants—how consistently does midrib hairiness correlate with confirmable examples of *L. gaudichaudii* and *L. koolauensis*?

Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 2 occurrences of *L. koolauensis* totaling approximately 280 individuals. The U.S. Army Garrison (2010) reported 16 adults and 329 immatures ranging from Kaukonahua (1 adult, 29 immature), Kawai Iki (15 adult), Kīpapa (100 immature), and Waiawa to Waimano (200 immature). Oahu Lowland Wet Unit 9 is considered unoccupied habitat (USFWS 2011a) for *L. koolauensis*. However, Bishop Museum vouchers (see Appendix C) record the historic presence of *L. koolauensis* inside Oʻahu Forest NWR boundaries, and flowering plants were noted in May 2005 on a steep slope with an estimated 100 plants of different sizes (Imada & LeGrande 2006a). In this report we counted 88+ plants, but since none were fertile, it was not possible to confidently state that they all represented *L. koolauensis* and not *L. gaudichaudii*. The bulk of the plants were noted at the Lobelia Bog campsite (60+ plants) in January 2010 at 790 meters (2,600 feet) elevation in the Koʻolau Prostrate *Metrosideros* Community (see Map 3, p. 55), at the same site where 100+ plants were noted in May 2005 and May 2006, when confirmed sightings of *L. koolauensis* were made (Imada & LeGrande 2006a). Another 20 vegetative plants were seen at 790 meters (2,600 feet) elevation on a steep, north-facing cliff also supporting colonies of *Labordia hosakana* (see Map 3), and scattered plants were also noted in the summit zone and another prostrate *Metrosideros* habitat (see Map 2, p. 54). Lammers (2007) noted that flowering occurs from late May to October, with fruits ripening from November to January. The primary threats in the refuge are competition with alien plants in its preferred habitats, including the grasses *Axonopus fissifolius* and *Sacciolepis indica*, and the melastomes *Clidemia hirta*.
and *Pterolepis glomerata*. Interestingly, plants of *Lobelia* sect. *Galeatella*, which includes *L. koolauensis* and *L. gaudichaudii*, are not monocarpic (flowering and fruiting only once before dying); instead, a new vegetative sucker can emerge from a root bud of the dying stem to replace it (Lammers 2007, 2009).

- **Lobelia oahuensis** (no common name, Campanulaceae, Endangered) is an unbranched shrub up to 3 meters tall with elliptic, 40–60 centimeter long leaves, the upper surface rough and glabrous, the lower surface densely grayish green hairy; the inflorescence is terminal, 3–5-branched from the base, 100–150 centimeters long, the flowers pale blue, 42–45 millimeters long (Wagner et al. 1990). *Lobelia oahuensis* is endemic to the Wai‘anae and Ko‘olau Mountains of O‘ahu and differs from the federally unprotected *L. hypoleuca* by its more rugose leaves and grayish green undersurface (versus white in *L. hypoleuca*). Currently, *L. oahuensis* is found in 7 occurrences totaling 41 individuals islandwide (USFWS 2011a); in the Ko‘olau Mountains it occurs on steep slopes or summit cliffs in cloudswept wet forest or lowland wet shrubland frequently exposed to heavy wind and rain (USFWS 2003). A recent five-year review of the conservation status of *L. oahuensis* (USFWS 2011d) described its presence since 1984 in the following areas along the central to southern Ko‘olau summits: Waikakalaua–Waikäne Ridge south of Pu‘u Ka‘aumakua, Waiawa, Mänana Trail to Kïpapa Trail, Mänana Stream, south of Mänana Summit, summit between Waimano and ‘Aiea, ‘Eleao, ‘Aiea Trail to Hälawa Trail summit, Pu‘u Keahiakahoe, Kōnāhuanui, Mount Olympus, Lanipō on the Kapakahī–Waimānalo–Wilhelmina Rise portions of the summit trail, summit of Kuli‘ou‘ou Valley and Pu‘u o Kona, and cliffs over Waimānalo, and estimated a Ko‘olau Mountains population of 39–59 individuals in three or four locations. Bishop Museum vouchers (see Appendix C) record the historic presence of *L. koolauensis* inside O‘ahu Forest NWR boundaries, and four plants were noted just outside the refuge boundary in 2003 (Hawai‘i Natural Heritage Program 2003).

- **Melicope hiakae** (alani, Rutaceae, Proposed Endangered) is a small tree 2–7 meters tall, endemic to O‘ahu, and historically found along the entire length of the Ko‘olau Range in lowland wet forest between 396 and 689 meters (1,300 and 2,260 feet) elevation. In Wagner et al. (1990), this species was known as *Pelea hiakae* and was treated as a synonym of *Pelea (=Melicope) wawraeana*; later, the species was resurrected by Hartley and Stone (1989). Vegetatively, *M. hiakae* can be difficult to distinguish from the more common *M. oahuensis* and *M. peduncularis*; fertile material is distinguished by its 1- to few-flowered inflorescences; long, club-shaped pedicels; and strongly lobed capsules, usually splotched with red. Currently there are 8 scattered occurrences totaling fewer than 40 individuals from Kawailoa to Waimalu (USFWS 2011a). Bishop Museum vouchers (see Appendix C) record the historic presence of *M. hiakae* inside O‘ahu Forest NWR boundaries, but no authentic recent sightings have been documented. During the 2010 survey, *Melicope* plants were noted that may be hybrids with *M. hiakae* involvement, but no pure *M. hiakae* were seen. The genus *Melicope* deserves further taxonomic research to better delimit species and understand hybridization patterns.

- **Melicope lydgatei** (alani, Rutaceae, Endangered) is a small shrub with distichous leaves, 2–3 per node; the capsules are 14–22 millimeters wide, completely glabrous, and lobed a quarter to a third their length (Wagner et al. 1990). In Wagner et al. (1990), this species was known as *Pelea lydgatei*. *Melicope lydgatei* is endemic to
the Koʻolau Mountains of Oʻahu, where it grow on ridges in mesic to wet forest (USFWS 2003). Wagner et al. (1990) described the species as possibly extinct and its range as disjunct: Hauʻula–Kahana, Mānana–Waimano, and Pālolo–Wailupe. Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 5 occurrences totaling 26 individuals. The U.S. Army Garrison (2010) reported 45 adults: 3 at Kaiwikōʻele–Kawaiulau Ridge, and 42 at Kawai Iki and ‘Ōpaeʻula; no plants were seen at historical localities in Poamoho or Mānana. Bishop Museum vouchers (see Appendix C) record the historic presence of *M. lydgatei* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented.

**Myrsine juddii** (kōlea, Myrsinaceae, Endangered) is a many-branched shrub up to 2 meters tall with narrowly ob lanceolate leaves 4–12 centimeters long, closely spaced and clustered toward the branch tips, the lower surface hairy along the midrib and toward the base (Wagner et al. 1990). It is endemic to the northern to central Koʻolau Mountains, found in lowland wet forest habitats on ridge crests or gulch slopes dominated by *Metrosideros* or a *Metrosideros-Dicranopteris* mixture (USFWS 2003). The U.S. Fish and Wildlife Service (USFWS 2011a) currently estimate a single wide-ranging occurrence of about 3,000 individuals; the U.S. Army Garrison (2010) estimates around 455 plants in the northern Koʻolaua ranging from Kaukonahua to Kamananui–Koloa. Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *M. juddii*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of Oʻahu Forest NWR; the closest recent collections were made at Poamoho around 4 kilometers north of Oʻahu Forest NWR (Bishop Museum Herbarium database, accessed 2011).

**Phyllostegia hirsuta** (no common name, Lamiaceae, Endangered) is an erect subshrub to scendent liana with densely long-hairy stems; opposite, rugose leaves, both surfaces hairy and moderately gland-dotted; and flowers arranged 6–18 per verticillaster (Wagner et al. 1990). It can be distinguished from the closely related *P. parviflora* by being densely hirsute, the hairs never gland-tipped (versus often gland-tipped in *P. parviflora*), and the calyx apices obtuse to rounded (versus attenuate to acute in *P. parviflora*) (Wagner et al. 1990). *Phyllostegia hirsuta* is endemic to lowland mesic to wet forests and wet cliff habitats in both the Waiʻanae and Koʻolau Mountains of Oʻahu, as well as montane wet habitats in the Waiʻanaes (Wagner et al. 1990; USFWS 2011a). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 9 occurrences totaling about 160 individuals islandwide. The U.S. Army Garrison (2010) reported 41 remaining adults and 22 immatures islandwide, including small populations in the northern Koʻolaua from Helemano–Poamoho–ʻŌpaeʻula (14 adult, 2 immature), Kaluanui (5 adult), and Kaipāpāʻu–Kawaiulau (9 adult); a small population at Kaukonahua had recently died. Bishop Museum vouchers (see Appendix C) record the historic presence of *P. hirsuta* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented.

**Phyllostegia parviflora** (no common name, Lamiaceae, Endangered) is a erect perennial herb closely related to *P. hirsuta*, but differing in being moderately hirsute, the hairs nearly as often gland-tipped as not, the calyx apices attenuate to acute, and the flowers arranged 4(6) per verticillaster (Wagner et al. 1990). The species includes three endemic varieties: var. *glabriuscula* (Hawaiʻi); var. *lydgatei* (Waiʻanae Mountains, Oʻahu); and
var. *parviflora* (Ko‘olau Mountains, O‘ahu, extinct on Maui) (Wagner 1999). Currently, *P. parviflora* var. *parviflora* is known from approximately 100 individuals (USFWS 2010a, 2011a) in the north to central Ko‘olau in lowland *Metrosideros* mixed wet forest and wet cliff habitats (USFWS 2003, 2011a); documented localities include North Kaukonahua Stream and Pu‘u Pauao, between Poamoho and Schofield–Waikäne Trail (Wagner 1999). Bishop Museum vouchers (see Appendix C) record the historic presence of *P. parviflora* var. *parviflora* inside O‘ahu Forest NWR boundaries, but no recent sightings have been documented.

**Plantago princeps** (ale, Plantaginaceae, Endangered) is a small shrub or robust perennial herb with leaves tufted at the stem tips, and is divided into four varieties; among them, two occur on O‘ahu: var. *princeps* (endemic to O‘ahu) and var. *longibracteata* (Kaua‘i and O‘ahu). Variety *longibracteata* is no longer considered to be extant on O‘ahu (USFWS 2003); it was last seen in 1976 (USFWS 2010b). *Plantago princeps* var. *princeps* has branched stems up to 0.6 meters long, leaves up to 20 centimeters long, and usually densely flowered spikes (Wagner et al. 1990). It is currently known from 7 occurrences totaling between 159 and 232 individuals, primarily in lowland mesic to wet forests and dry cliff ecosystems in the Wai‘anae Mountains (USFWS 2011a). In the Ko‘olau Mountains, it has historically been found in upper portions of the leeward central Ko‘olau Mountains, on slopes or ledges in *Metrosideros* (‘ōhi‘a) lowland mesic forest or shrubland (USFWS 2003): the most recent observations are from the Mānana summit area in 2000 at 629 meters (2,060 feet) elevation, 2 individuals; Waiawa, 2006, 16 mature and 17 immature individuals, and 50 seedlings; and Nu‘uanu Valley, on cliffs below the Mānoa Cliff Trail, 2008, 1 individual (USFWS 2010b). Oahu Lowland Wet Unit 9 is unoccupied habitat for var. *longibracteata*, but occupied habitat for var. *princeps* (USFWS 2011a). There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR.

**Platanthera holochila** (no common name, Orchidaceae, Endangered) is a usually terrestrial orchid up to 0.6 meters tall with cauline leaves and terminal spikes of greenish yellow flowers (Wagner et al. 1990). It is historically known from Kaua‘i, O‘ahu, Moloka‘i, and Maui in *Metrosideros-Dicranopteris* (‘ōhi‘a-uluhe) wet forest or *Metrosideros* mixed shrubland (USFWS 2003), but is considered extinct on O‘ahu, having been last collected in the central Ko‘olau Mountains in 1937 and 1938 [Fosberg & Hosaka 13998, “main divide, Pu‘u Ka‘inapua‘a”; Hosaka & Fosberg 1906, “head of Kawainui Gulch”; Neal & Harro s.n., 3 July 1938, “summit of Kawaiola–Punalu‘u Trail”; Selling 2622, “head of Kïpapa Gulch”] (USFWS 2011a; Bishop Museum Herbarium database, accessed 2011). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *P. holochila*.

**Platydesma cornuta** var. *cornuta* (no common name, Rutaceae, Proposed Endangered) is a palmlike shrub up to 2 meters tall with opposite, narrowly obovate to oblong-spatulate leaves 12–40 centimeters long, the base abruptly truncate or obtuse at the juncture with the petiole; flowers on stems below the leaves, petals 4, white, 9–16 millimeters long; and the capsule 16–33 millimeters in diameter, with 4 sharp beaks (Wagner et al. 1990). *Platydesma cornuta* var. *cornuta* is endemic to the Ko‘olau Mountains of O‘ahu, where it occurs in wet forest, shrubland, and gulches in lowland wet habitats between 579 and 762 meters (1,900 and 2,500 feet) elevation.
O‘ahu Forest National Wildlife Refuge Botanical Survey

(USFWS 2011a). A second variety, *P. cornuta* var. *decurrens*, is restricted to the Wai‘anae Mountains. Historically, *P. cornuta* var. *cornuta* was found along the entire length of the Ko‘olau Range from Pūpūkea to Waiulu Valley (Bishop Museum Herbarium database, accessed 2011). Currently, 9 occurrences totaling 32 individuals are restricted to the summit area of the northern Ko‘olau Mountains, with only a single occurrence of 16 individuals near the summit of the southern Ko‘olau (USFWS 2011a). Bishop Museum vouchers (see Appendix C) record the historic presence of *P. cornuta* inside O‘ahu Forest NWR boundaries, but no recent sightings have been documented.

- **Polyscias gymnocarpa** (‘ohe‘ohe, Araliaceae, Endangered) is a tree up to 10 meters tall, usually mealy pubescent on the young leaves and inflorescences; the pinnately compound leaves have 7–21 leaflets (Wagner et al. 1990). It is distinguishable from the more common *T. oahuensis* by its darker green coloration, larger number of leaflets, presence of mealy pubescence on the leaf undersides and inflorescences, and superior ovary. In Wagner et al. (1990), this species was known as *Tetraplasandra gymnocarpa*, but recent molecular work by Lowry and Plunkett (2010) showed that several Paleotropical araliaceous genera were nested within a broadly defined genus *Polyscias*, including all endemic Hawaiian members of the genera *Munroidendron*, *Reynoldsidea*, and *Tetraplasandra*; thus, all members of those genera have been transferred into *Polyscias*.

*Polyscias gymnocarpa* occurs in the Ko‘olau Mountains and a historic single location in the Wai‘anae Mountains, O‘ahu (USFWS 2003). In the Ko‘olau, *P. gymnocarpa* is known from windswept summit ridges, slopes, and gullies in wet to sometimes mesic lowland forest or shrubland, historically ranging from Pūpūkea in the north down to Kuli‘ou‘ou and Waimānalo at the southeastern end (USFWS 2003). Currently, there are 13 occurrences totaling approximately 140 individuals (USFWS 2011a). Bishop Museum vouchers (see Appendix C) record the historic presence of *P. gymnocarpa* inside O‘ahu Forest NWR boundaries, and 7 plants were recently noted in the refuge by Hawai‘i Natural Heritage Program (2003). During the 2010 survey, a total of 14 plants (13 adult, 1 immature) were observed (see Map 2, p. 54). Because they are fairly distinctive in the landscape, 9 of the plants were only observed with binoculars and identified from afar, such as across a valley, and drawn in on a map based on a best estimate; in one case, a rangefinder was used to mark the location of a faraway plant. The plants were widely scattered on upper, middle, or lower slopes, and most were vegetative; in January 2010, one plant was in bud, flower, and immature fruit, while in October 2010 one plant was fruiting, and another had buds, flowers, and immature fruit. The major threats to *P. gymnocarpa* in the refuge are probably competition with alien plant species such as *Heliocarpus popayanensis* (white moho), *Schefflera actinophylla* (octopus tree), *Psidium cattleianum* (strawberry guava), *Clidemia hirta* (Koster’s curse), and potentially *Ardisia elliptica* (shoebutton ardisia), if it successfully disperses itself from the lower mesic sections.
• **Psychotria hexandra** subsp. *oahuensis* (kōpiko, Rubiaceae, Proposed Endangered) is a tree or shrub up to 6 meters tall, vegetatively similar to the common *P. mariniana*, but with larger stipules; the inflorescence is thrice-branched, with usually 6-lobed white flowers, the corolla tube 6–13 millimeters long (Wagner et al. 1990), much larger than that of any other *Psychotria* species on O‘ahu. *Psychotria hexandra* subsp. *oahuensis* is endemic to the Koʻolau Mountains, O‘ahu, occurring in wet forest and shrubland in lowland wet and wet cliff ecosystems between 329 and 610 meters (1,080 and 2,000 feet) elevation (Wagner et al. 1990), and is further subdivided into three varieties: var. *hosakana*, historically known from the Kïpapa area; var. *oahuensis*, recorded from the north to central Koʻolaus; and var. *rockii*, historically from behind Honolulu (Wagner et al. 1990; Bishop Museum Herbarium database, accessed September 2011). This taxon is currently known only from three occurrences in the northern Koʻolau Mountains: Maʻakua Gulch, one occurrence of 8–9 individuals; ‘Ōpaeʻula Gulch, 1 individual; and between Kaipāpaʻu and Kaluanui, fewer than 10 scattered individuals (USFWS 2011a). Oahu Lowland Wet Unit 9 is considered unoccupied habitat (USFWS 2011a) for *P. hexandra* subsp. *oahuensis*. Bishop Museum vouchers (see Appendix C) record the historic presence of *P. hexandra* subsp. *oahuensis* inside O‘ahu Forest NWR boundaries, but no recent sightings have been documented.

• **Pteralyxia macrocarpa** (kaulu, Apocynaceae, Proposed Endangered) is a tree 8–15 meters tall with broadly elliptic to obovate or suborbicular blades 9–18 centimeters long, the upper surface dark green and shiny; 5-lobed flowers 7–9 millimeters long; and bright red, obovoid to ellipsoid fruit (Wagner et al. 1990). It is endemic to the Waiʻanaes and Koʻolau Mountains, occurring in lowland mesic to wet forests, and dry and wet cliff habitats between 335 and 850 meters (1,100 and 2,800 feet) elevation (USFWS 2011a), and was found historically along the entire length of the Koʻolau Range from Pūpūkea, ‘Ōpaeʻula, Kawaiola, Kawai Iki, and Makaua in the north; Waimalu in the central Koʻolaus; and Kalihi, Nuʻuanu, Waiʻalae Iki, and Wailupe further south (Bishop Museum Herbarium database, accessed 2011), and on the summit ridges of the Waiʻanaes. *Pteralyxia macrocarpa* is currently known from 31 occurrences totaling between 233 and 289 individuals in the Waiʻanaes; 7 occurrences totaling 47 individuals in the northern Koʻolaus; and 2 occurrences totaling 11 individuals in the southern Koʻolaus (USFWS 2011a). Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *P. macrocarpa*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of O‘ahu Forest NWR.

• **Pteris lydgatei** (no common name, Pteridaceae, Endangered) is a terrestrial fern found on steep streambanks or cliffs in wet *Metrosideros-Dicranopteris* (ʻōhiʻa-uluhe) forest, known from O‘ahu, Molokaʻi, and Maui (USFWS 2003). The fronds are 30–95 centimeters long; the 1-pinnate to 2-pinnate-pinnatifid blades are dark gray-green, thick, rough, and brittle; and the sori are marginal and usually interrupted (Palmer 2003). On O‘ahu, the U.S. Fish and Wildlife Service (USFWS 2011a) currently reports 5 occurrences totaling between 17 and 24 individuals in the Koʻolau Mountains. The U.S. Army Garrison (2010) reported 9 adults and 5 immatures in the
central to northern Koʻolau, ranging from Kawainui to Kawai Iki, Helemano, Kaluanui, and North and South Kaukonahua north of Oʻahu Forest NWR, and 2 immature individuals reported in Waimano south of OFNWR, within Oahu Lowland Wet Unit 9. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of Oʻahu Forest NWR.

- **Sanicula purpurea** (no common name, Apiaceae, Endangered) is a stout perennial herb up to 36 centimeters tall with decumbent stems; reniform to orbicular or ovate-cordate, 3–7-lobed basal leaves, each 2–8 centimeters wide; and a paniculate umbel with tiny purple or cream-colored flowers (Wagner et al. 1990). It is endemic to the Koʻolau Mountains, Oʻahu, and West Maui on open *Metrosideros* mixed montane bogs or windswept shrubland in the cloud zone (USFWS 2003). Currently, the West Maui population is about 200 plants (USFWS 2010a); the Koʻolau numbers range from 24 individuals (USFWS 2011a) to 6 mature and 71 immature plants (U.S. Army Garrison 2010) concentrated in the northern Koʻolau from north of Puʻu Pauao (21 immature), Poamoho (2 adult, 10 immature), and the Schofield–Waikãne Trail summit (2 adult, 40 immature), with a small population on the Waiupe–Waimānalo summit ridge (2 adult). Oahu Lowland Wet Unit 9 is considered unoccupied habitat (USFWS 2011a) for *S. purpurea*. Bishop Museum vouchers (see Appendix C) record the historic presence of *S. purpurea* inside Oʻahu Forest NWR boundaries, but no recent sightings have been documented.

- **Trematolobelia singularis** (no common name, Campanulaceae, Endangered) is an unbranched shrub up to 1.5 meters tall with linear-elliptic blades 10–18 centimeters long; the terminal inflorescence is 30–42 centimeters long with violet flowers (Wagner et al. 1990). All species in this Hawaiian endemic genus are (almost without exception) monocarpic, the entire plant dying after the seed is matured (Lammers 2009). It is endemic to lowland wet and wet cliff habitats in the Koʻolau Mountains, Oʻahu (USFWS 2011a). *Trematolobelia singularis* can be distinguished from the more common *T. macrostachys* by its usually unbranched, erect inflorescence (versus 5–20 horizontal, spokelike racemes in the latter); vegetatively, the stems of *T. singularis* are distinctly rougher, with a shiny raised bump below each leaf scar, compared to the smoother stems of *T. macrostachys* (Joel Lau, pers. obs., 2010). Historically occurring on the Moanalua–Tripler Ridge summit to Puʻu Keahiakahoe, Kōnāhuanui, and Puʻu Lanipo (USFWS 2009d), *T. singularis* is currently found in 4 occurrences totaling approximately 360 individuals (USFWS 2011a), at Waiawa, Moanalua, Kōnāhuanui, and Wailupe (Plant Extinction Prevention Program 2008), all to the south of Oʻahu Forest NWR. Oahu Lowland Wet Unit 9 is unoccupied habitat (USFWS 2011a) for *T. singularis*. There are no Bishop Museum voucher records to document its historical presence in the immediate vicinity of Oʻahu Forest NWR. In March 2011, Koʻolau Mountains Watershed Partnership staff documented the presence of 10 plants of *T. singularis* in two locations along the Koʻolau summit south of the Kipapa Trail above the Waiawa drainage at 850 meters (2,785 feet) elevation and within the southern border of Oʻahu Forest NWR; several plants were fruiting (Scott Lynch, Koʻolau Mountains Watershed Partnership, pers. comm., 2011). Flowering in *T. singularis* occurs in October (Lammers 2009).
• **Viola oahuensis** (no common name, Violaceae, Endangered) is a usually unbranched subshrub up to 0.4 meters tall with alternate, elliptic to ovate leaves 3–12 centimeters long, clustered toward the apex; the flowers are single or paired, with 5 pale yellow petals (Wagner et al. 1990). It is endemic to the Ko‘olau Mountains of O‘ahu and historically ranged from Kawailoa to Pālolo along exposed, windswept summit ridges of moderate to steep slope in wet *Metrosideros-Dicranopteris* (*ʻōhi‘a-uluhe*) shrubland or *Metrosideros* mixed montane bogs in the cloud zone (Wagner et al. 1990; USFWS 2003). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 8 occurrences totaling approximately 170 individuals. The U.S. Army Garrison (2010) reported 284 adults and 163 immatures, including at Koloa (31 adult, 8 immature), Kawai Iki (13 adult, 9 immature), Helemano–ʻŌpae‘ula (163 adult, 146 immature), and Kaukonahua (25 adult) north of O‘ahu Forest NWR, and Waimalu–Kahalu‘u summit (50 adult) south of the refuge. Oahu Lowland Wet Unit 9 includes populations known from the summit between Waiau and Waimalu (U.S. Army Garrison 2010; USFWS 2010a). Bishop Museum vouchers (see Appendix C) record the historic presence of *V. oahuensis* in O‘ahu Forest NWR boundaries, but no recent sightings have been documented.

• **Zanthoxylum oahuense** (a‘e, Rutaceae, Proposed Endangered) is a monoecious tree up to 6 meters tall with fragrant, trifoliate, opposite leaves reminiscent of *Cheirodendron* (*ʻōlapa*); the petioles are twice jointed, at the base and near the blade (Wagner et al. 1990). It is endemic to O‘ahu, where it has historically been known along the entire length of the Ko‘olau Mountains in lowland wet forest between 628 and 829 meters (2,060 and 2,720 feet) elevation (USFWS 2011a). *Zanthoxylum oahuense* is currently restricted to 8 occurrences totaling about 29 individuals in the northern and central Ko‘olau Mountains from Pu‘u Ka‘inanapua‘a along the summit to Waimano Stream (USFWS 2011a) and south to Kalauao Valley (Imada & LeGrande 2006b). Oahu Lowland Wet Unit 9 includes a number of historic vouchers (see Appendix C) and known populations in Waimano, O‘ahu Forest NWR (Imada & LeGrande 2006a), and Kalauao (Imada & LeGrande 2006b). Bishop Museum vouchers (see Appendix C) also record the historic presence of *Z. oahuense* inside O‘ahu Forest NWR boundaries. Two additional trees were noted during the October 2010 survey (see Map 2, p. 54): a 3–4 meter tall vegetative adult tree, noted on a 45–70 degree upper slope at 730 meters (2,400 feet) elevation, growing with *Syzygium sandwicensis* (*ʻōhi‘a hā*), *Bobea elatior* (*ʻahakea lau nui*), and *Wikstroemia oahuensis* (*ʻākia*); and a smaller immature tree growing mid-slope on a steep uphill climb, 707 meters (2,320 feet) elevation, with *Machaerina angustifolia* (*ʻuki*), *Metrosideros rugosa* (lehua papa), *Kadua fosbergii* (manono), *Syzygium sandwicensis, Bidens macrocarpa* (koʻokoʻolau), and *Dicranopteris linearis* (uluhe).
II. METHODOLOGY

Due to the remoteness of the survey area in the upland central Ko‘olau Mountains (see Map 1, p. 53), the chosen survey strategy was to be transported in by helicopter, along with slingloads of camping gear, food and water, a generator, and other supplies, for extended overnight campouts. For this survey, teams were assembled to conduct two campout trips totaling 7 days and 5 nights, with each trip set up at different base camps (Waipi‘o/Lobelia Bog Base Camp/Landing Zone and Kipapa/Manuka Platform Base Camp/Landing Zone). Map 2 (p. 54) pinpoints the base camps and survey routes. While the established Kipapa Trail provided a clear main transit route for the October 2010 trip, in general the nature of the rugged terrain and dearth of established trails necessitated that survey routes were to some extent dictated by the presence of topographic obstacles. Thus, the survey for the most part was not conducted in a systematic, gridlike fashion using transects, but instead was guided by a combination of topography and the exploration of promising reachable native habitats.

Survey routes were selected to complement those traversed in the 2003 (Hawai‘i Natural Heritage Program 2003) and 2005–06 Bishop Museum (Imada & LeGrande 2006) surveys, although there was some overlap to check up on previously sighted rare plant taxa. The fieldwork strategy was to walk survey routes from base camp in teams of various configurations (with nine field members on each trip, teams were generally split up between three and six members) while recording rare plant species locations and unique native plant communities, noting all vascular plant taxa seen, and observing habitat management concerns. GPS points were taken frequently along transects, and routes were mapped. Rare plants and communities, as well as weedy species of management concern, were georeferenced when possible; in some cases, such as in steep-sided gulches or sightings with binoculars, GPS readings were not possible and point localities were approximated on USGS maps. Because surveys of endangered and threatened species greatly benefit from accurate collection of location points so that data layers can be overlaid, intricate spatial relationships can be determined, and species can be relocated in the future, georeferencing was done with GeoXT Trimble GPS units during the January 2010 survey. A GeoXT unit provides 1–3 meter accuracy, simplifying relocation efforts, and, combined with ArcPad and GPS Correct software, allows users to input attribute data at the site and differentially correct the data in ArcGIS at the office. Unfortunately, no qualified Trimble operators were available for the October 2010 trip, where Garmin GPS units (e.g., Garmin GPS 60) were used. All of the survey data was converted to NAD83, UTM zone 4N using ArcMap 9.03.

In preparing for fieldwork, laminated field identification cards were created to assist field staff with identifications of a selection of rare plants and invasive species they might encounter during the survey. Copies of these cards can be seen in Appendix E. Such cards could be created for other refuges in the O‘ahu National Wildlife Refuge Complex.

Trip 1 (11–13 January 2010) Clyde Imada, Dr. Shelley James (Bishop Museum); Jason Hanley, Cheryl Phillipson (U.S. Fish and Wildlife Service); Joel Lau; Patti Clifford (Hawai‘i Invasive Species Council/Weed Risk Assessment); George Akau and B.J. Davis (Ko‘olau Mountains Watershed Partnership); Alex Lau (O‘ahu Invasive Species
Committee/Oʻahu Early Detection). Helicopter drop at Waipiʻo (Lobelia Bog) LZ for 3-day botanical survey of ridges and valleys in camp vicinity and areas south of camp.

Trip 2 (12–15 October 2010) Clyde Imada (Bishop Museum); Joel Lau; B.J. Davis, Scott Lynch, Paul Roman, Adam Williams (Koʻolau Mountains Watershed Partnership); Danielle Frohlich, Alex Lau (Oʻahu Invasive Species Committee/Oʻahu Early Detection); Matt Stelmach (U.S. Fish and Wildlife Service). Helicopter drop at Kipapa (Manuka) Platform LZ for 4-day botanical survey of ridges and valleys in the vicinity of, and to the north of, Kipapa Trail.

III. RESULTS

A total of 165 taxa were noted during the survey, including 105 endemic, 14 indigenous, 43 naturalized, and 3 Polynesian-introduced taxa (see Appendix A). Thus, about 72% of taxa seen were native, attesting to the relatively undisturbed nature of the vegetation. By comparison, over 70 years ago Hosaka (1937) calculated that 83% (85 of 102) of plant taxa were native in his ‘Ōhi‘a Zone and 89% (51 of 57) in his Cloud Zone.

IIIa. Vegetation Zones

The vegetation zones of Oʻahu Forest National Wildlife Refuge vary by elevation, wind exposure, slope, and substrate. Six vegetation types were observed in OFNWR, all structural variants of Lowland Wet communities. They are briefly characterized here, along with the plant species typically associated with each habitat. The vegetation classification system of Gagné and Cuddihy (1990) was adapted for this section. The descriptions below borrow liberally from characterizations provided in Imada & LeGrande (2006).

Lowland Wet Forests

Metrosideros/Dicranopteris (ʻŌhiʻa/Uluhe) Fern Forest: Many of the main ridges and side ridges in the upper sections of the survey area are dominated by Dicranopteris linearis (uluhe) fern thickets, which tend to form a continuous blanket with emergent trees such as Metrosideros polymorpha (ʻōhiʻa lehua), Kadua spp. (manono), Myrsine spp. (kōlea), Syzygium sandwicensis (ʻōhiʻa hā), Bobea elatior (ʻahakea lau nui), and Ilex anomala (kāwaʻu). Some alien plant species noted in this community are Pterolepis glomerata, Axonopus fissifolius (narrow-leaved carpetgrass), Clidemia hirta (Kosterʻs curse), and Rubus rosifolius (thimbleberry).

Metrosideros (ʻŌhiʻa) Lowland Wet Forest: The main valley of Kipapa is dissected by alternating side ridges and gulches that lead down to the many upper headwater streams. The vegetation at the tops of these ridges
tends to be more windswept, with a dominant groundcover of fern and scattered trees (‘Ōhi’a/Uluhe Fern Forest). As the ridges lose elevation and tend to be less exposed to the sun and wind, tree species become more numerous and condensed and the filtered understory is more speciose. The dominant *Metrosideros polymorpha* stands are interspersed with *Bobea elatior*, *Kadua affinis* (manono), *Pittosporum glabrum* (hō’awā), *Syzygium sandwicensis*, *Psychotria* spp. (kōpiko), and *Melicope* spp. (alani). The understory is comprised of few shrubs, including *Wikstroemia oahuensis* (‘ākia), *Broussaiaia arguta* (kanawao), *Pipturus albidus* (māmaki), and *Clidemia hirta*. Ferns such as *Cibotium* spp. (häpu‘u) and *Nephrolepis* spp. are intermixed with climbing and vining species such as *Freycinetia arborea* (‘ie‘ie), *Smilax melastomifolia* (hoi kuahiwi), and *Alyxia stellata* (maile). Most of the endangered *Polyscias gymnocarpa* (‘ohe‘ohe) trees and *Zanthoxylum oahuense* (a‘e) were located in this habitat.

**Metrosideros/Cheirodendron (‘Ōhi’a/Ōlapa) Forest:** The headwaters of Kīpapa Valley originate at the summit ridge that divides the windward and leeward range of the Ko‘olau Mountains. The drainages that begin at the summit catch the trade winds and clouds that blow over the summit, creating a wet cloud zone dominated by a somewhat dwarfed forest of *Metrosideros polymorpha*, *Cheirodendron* spp. (‘ōlapa), *Kadua* spp., *Dubautia* spp. (na‘ena‘e), *Ilex anomala*, *Pipturus albidus*, *Platydesma spathulata* (pilo kea), *Scaevola mollis* (naupaka kuahiwi), *Plantago pachyphylla* (laukahi kuahiwi), and *Cibotium* spp. Alien species observed in this zone included *Rubus rosifolius* and *Clidemia hirta*.

**Lowland Wet Shrublands**

**Metrosideros (‘Ōhi’a) Lowland Wet Shrubland:** This plant community is restricted to the main summit ridge and the upper ridges of Kīpapa Valley. The windswept ridge is dominated by groundcovers consisting mainly of *Dicranopteris* interspersed with *Vaccinium* sp. (‘ōhelō), *Machaerina angustifolia* (‘uki), *Plantago pachyphylla*, and *Clidemia hirta*. In areas below the ridgelines where plants are slightly more protected from the strong winds, stunted tree species of *Metrosideros rugosa* (lehua papa), *Kadua* spp., *Polyscias oahuensis* (‘ohe mauka), *Cheirodendron platyphylllum* (lapalapa), *Ilex anomala*, *Scaevola* spp. (naupaka kuahiwi), and *Myrsine* spp. can be seen. Dominant shrubs include *Wikstroemia oahuensis*, *Dubautia laxa* (na‘ena‘e pua melemele), *Coprosma longifolia* (pilo), and *Broussaiaia arguta*.

**Lowland Wet Mixed Communities**

**Machaerina (‘Uki) Mixed Shrub and Sedgeland:** Steep, wind-buffeted windward cliffs along the Ko‘olau summit with heavy rainfall support a low-statured mixed shrub and sedgeland matted with mosses and liverworts. Emergent trees are infrequent except for *Pritchardia martii* (loulu) groves usually extending down drainages. The low mix includes *Machaerina angustifolia*, *Dubautia laxa* (na‘ena‘e), *Bidens macrocarpa* (ko‘oko‘olau), *Metrosideros rugosa* (lehua papa), *Sadleria pallida* (‘ama‘u ‘i‘i), *Scaevola mollis*, *Kadua* spp., *Pritchardia martii* (loulu), and *Scaevola* spp. (naupaka kuahiwi).
Trematolobelia macrostachys (koli’i), Axonopus fissifolius, Clidemia hirta, and Pterolepis glomerata. Labordia hosakana (kāmakahala) and Lobelia koolauensis/audichaudii were noted in this habitat.

Koʻolau Prostrate Metrosideros (ʻOhi’a) Community:
Encountered on our survey on two ridge systems in the Kīpapa drainage (see Map 3, p. 55) was a vegetation type that is noteworthy and deserving of conservation attention. This vegetation type is found in a limited number of sites in the Koʻolau Mountains. It is characterized by the dominance of a prostrate form of Metrosideros polymorpha and its prostrate hybrids. This form of Metrosideros falls into M. polymorpha var. pumila as treated by Dawson and Stemmermann (1990). However, its taxonomic status apparently needs to be re-evaluated, as it is markedly different from some other forms of Metrosideros referred to var. pumila. Koʻolau Prostrate Metrosideros Community occurrences are known only from the Koʻolau Mountains from Koloa Gulch in the north to Moanalua in the south. The occurrences have been observed primarily to the lee of the Koʻolau summit divide in areas where the topography causes the prevailing trade winds to be stronger than normal. The assemblage is usually found on ridgetops and ridge shoulders exposed to the full force of the trade winds.

This vegetation type is similar in its physiognomy and in its taxon composition to Metrosideros-dominated bog vegetation on the islands of Kaua‘i, Moloka‘i, Maui, and Hawai‘i, in Wagner et al. (1990) classified as Metrosideros (ʻOhi’a) Montane Wet Mixed Communities. On those islands, prostrate forms of Metrosideros occur primarily in montane bogs. Several of the Koʻolau Prostrate Metrosideros Community’s component plant taxa normally found only in montane bogs on the neighbor islands are restricted or almost restricted on Oʻahu to this assemblage. These plants include Rhynchospora chinensis subsp. spiciformis [first reported from Oʻahu in a similar bog community in the Koʻoluaus north of OFNWR (Gon 1994), and first vouchered from Oʻahu in a prostrate Metrosideros habitat off ‘Aiea Ridge Trail (Kennedy et al. 2010)]; Panicum hillebrandianum (not previously reported from Oʻahu); Vaccinium pahalae (ʻōhelo) [in Wagner et al. (1990), the species was synonymized under V. reticulatum, but its taxonomic status may need to be re-examined; it differs from V. reticulatum by being diminutive, very pubescent, with
bright red fruit and strongly revolute leaves (Wagner et al. 1990)]; and a prostrate form of *Leptecophylla taneiameiae* (pūkiawe). The Endangered *Lobelia koolauensis* occurs primarily in or along the borders of this vegetation type.

Other native components in this habitat include the grasses *Panicum koolauense* and *Isachne distichophylla* (‘ohe); ferns and fern allies *Sadleria pallida* (‘ama‘u ‘i‘i), *Cibotium glaucum* (hāpu‘u pulu), *Sphenomeris chinensis* (pala‘a), *Lycopodiella cernua* (wāwae‘iole), and *Dicranopteris linearis* (uluhe); the herbs *Bidens macrocarpa* (ko‘oko‘olau) and *Plantago pachyphylla* (laukahi kuahiwī); the shrubs *Scaevola* spp. (naupaka kuahiwi) and *Dubautia laxa* (na‘ena‘e); and a variety of mosses and liverworts. Non-native plants include *Sacciolepis indica* (Glenwood grass), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Pterolepis glomerata*, and *Clidemia hirta* (Koster’s curse). Competition with invasive weeds is probably the biggest threat to this community, as there was no evidence of pig damage during our survey. If fencing in O‘ahu Forest NWR were eventually conducted on a small-scale basis to circumvent pig damage, this community type would be a top candidate for such a management action.

### IIIb. Noteworthy Plant Discoveries/Taxa of Conservation Significance
(See Maps 2 & 3, pp. 54, 55)

Ten rare species were noted during the 2010 surveys; most are profiled here except the four Endangered species, which are profiled where treated alphabetically in section 1d (Endangered Species and Critical Habitat Designations). Rare plant points can be found on Map 2 (p. 54), and rare plant/community polygons are displayed on Map 3 (p. 55). The assigned conservation status categories for each species as designated by the U.S. Fish and Wildlife Service (2010a) are defined below; these were taken from [http://www.fws.gov/endangered/about/listing-status-codes.html](http://www.fws.gov/endangered/about/listing-status-codes.html) (except for the “Apparently Secure” definition).

- **Endangered** (official designation for a taxon in danger of extinction throughout all or a significant portion of its range): *Cyanea koolauensis, Euphorbia rockii, Lobelia koolauensis, Polyscias gymnocarpa*
- **Candidate** (a taxon under consideration for official listing for which there is sufficient information to support listing): *Myrsine fosbergii*
- **Proposed Endangered** (a taxon proposed for official listing as endangered): *Zanthoxylum oahuense*
- **Species of Concern** (a taxon that has not been petitioned or been given Endangered, Threatened, or Candidate status but has been identified as important to monitor): *Labordia hosakana, Lobelia gaudichaudii, Panicum koolauense*
- **Apparently Secure** (not an official designation; indicative that the taxon is not currently considered to be at risk): *Lobelia hypoleuca*

None of the rare vascular plant taxa noted during the 2010 O‘ahu Forest NWR surveys were among those being monitored or managed by the Plant Extinction Prevention (PEP) Program, which is supported by federal, state, and private funding to implement recovery actions for plant taxa numbering fewer than 50 remaining wild individuals (‘the
rarest of the rare”), including those that may not yet be federally listed. On the PEP Program target list of 200 taxa for 2010, 39 had historically been recorded from O‘ahu. The PEP Program is dedicated to implementing the “Interim Criteria” identified in federally listed species’ recovery plans, as well as the endangered plant protection actions outlined in the State of Hawai‘i’s Comprehensive Wildlife Conservation Strategy (October 2005; http://www.state.hi.us/dlnr/dofaw/cwcs/index.html) for their respective islands, through surveys, population monitoring, collection for ex situ cultivation, and threat management (Plant Extinction Prevention Program 2010).

• **Cyanea koolauensis** (hähä, Campanulaceae, Endangered)—Five plants noted; see page 8 for details.

• **Euphorbia rockii** (‘akoko, Euphorbiaceae, Endangered)—One plant noted; see page 12 for details.

• **Labordia hosakana** (kāmakahala, Loganiaceae, Species of Concern) is a low-growing, many-branched shrub up to 0.5 meters tall with dark green, leathery, rugose, ± elliptic leaves 1.5–5 centimeters long, the veins on the upper surface deeply impressed, the lower surface pale green; and flowers in sessile cymes, the corolla 5–7-lobed, yellowish orange, 15–20 millimeters long (Wagner et al. 1990). It is scattered on open, cloudswept summit in wet forest in the Ko‘olau Mountains, O‘ahu, often on windward faces, ranging from Pu‘u Ka‘inapua‘a north of O‘ahu Forest NWR, to Wa‘ahila south of the refuge (Bishop Museum Herbarium database, accessed 2011). When last assessed in 1999, 5 populations totaling 200+ plants were estimated (USFWS 2010a). Noted but not counted during the 2005–2006 survey (Imada & LeGrande 2006), 34 plants were counted in 2010 (see Maps 2 & 3, pp. 54, 55) on steep, everwet exposures. The 6 plants counted in January 2010 were all noted on the Ko‘olau summit ridge, off the windward slope, associated with *Machaerina angustifolia* (‘uki), *Dubautia laxa* (na‘ena‘e pua melemele), *Bidens macrorcarpa* (ko‘oko‘o‘olau), *Metrosideros polymorpha* (‘ōhi‘a), *Sadleria pallida* (‘ama‘u ‘i‘i), *Sphenomeris chinensis* (pala‘ā), *Axonopus fissifolius* (narrow-leaved carpetgrass), *Clidemia hirta* (Koster’s curse), and *Pterolepis glomerata*; in October 2010, all 28 plants seen were on steep leeward slopes within the refuge, including a concentration of 27 plants at 790 meters (2,600 feet) elevation, associated with *Lobelia* spp., *Plantago pachyphylla* (laukahī kuahiwi), *Isachne distichophylla* (‘ohe), *Dubautia laxa*, and *Axonopus fissifolius*. In March 2011, Ko‘olau Mountains Watershed Partnership staff discovered 14 additional plants of *L. hosakana* in four locations along the Ko‘olau summit south of the Kipapa Trail above the Waiawa drainage (Scott Lynch, Ko‘olau Mountains Watershed Partnership, pers. comm., 2011). Weed competition is probably its main threat, especially from *Axonopus fissifolius*, *Sacciolepis indica* (Glenwood grass), and *Clidemia hirta*.

• **Lobelia gaudichaudii** (no common name, Campanulaceae, Species of Concern) is an unbranched shrub up to 3 meters tall, the stout stem up to 5 centimeters in diameter, with a dense apical rosette of sessile, oblanceolate leaves 9–20 centimeters long, the margins revolute; the terminal inflorescence is up to 0.8 meters tall, unbranched, with red flowers (Lammers 2007). It is endemic to the southeastern Ko‘olau Mountains on
O‘ahu Forest National Wildlife Refuge Botanical Survey

moderate to steep slopes in Mertosideros lowland wet shrubland or bog (USFWS 2003) between Pu‘u Pauao and Mount Olympus (Lammers 2007). This species consisted of two varieties: var. gaudichaudii, as described above; and var. koolauensis, from the northern Ko‘olaus, differing by its white flowers and branching inflorescences (Wagner et al. 1990), until Lammers (2007) elevated L. gaudichaudii subsp. koolauensis to a full species as L. koolauensis. See the L. koolauensis profile on p. 14 for a discussion of their overlapping geographic ranges and difficulty in identifying vegetative specimens. Bishop Museum vouchers (see Appendix C) record the historic presence of L. gaudichaudii inside O‘ahu Forest NWR boundaries. A confirmed sighting of L. gaudichaudii was made in 2003 (Hawai‘i Natural Heritage Program 2003) in the vicinity of the Lobelia Bog landing zone (See Map 2), but no flowering plants were seen to confirm its presence during the 2005–2006 (Imada & LeGrande 2006a) or 2010 rare plant surveys. In this report we counted 88+ Lobelia plants (see Maps 2 & 3), but no plants were fertile, making the distinction between L. koolauensis and L. gaudichaudii impossible. When last assessed in 2007, less than 15 populations with 100–200 individuals were estimated (USFWS 2010a). Lammers (2007) noted that flowering occurs from July to October, with fruits ripening from November to January.

- **Lobelia hypoleuca** (kuhi‘aikamo’owahie, Campanulaceae, Apparently Secure) is an unbranched shrub up to 0.3 meters tall with narrowly elliptic to elliptic leaves 30–65 centimeters long, densely white tomentose on the underside; and a 3–7-branched, terminal inflorescence 15–40 centimeters long, the flowers blue, 28–32 millimeters long (Wagner et al. 1990). It is the most wide-ranging of all endemic members of the lobelia family, historically known from Kaua‘i, O‘ahu, Moloka‘i, Lāna‘i, Maui, and Hawai‘i (Wagner et al. 1990). Its conservation status was last assessed in 1999, when thousands of individuals were estimated in an unknown number of populations (USFWS 2010a). While not yet on the radar screen for Federal protection, it is not that commonly seen on O‘ahu; thus, its sighting in the refuge is mentioned here. In October 2010, a single 1.5 meter tall plant was noted in a gulch bottom in Kïpapa Stream with a 6-branched inflorescence in full bloom at 550 meters (1,800 feet) elevation (see Map 2, p. 54), in association with Dicranopteris linearis (uluhe), Pipturus albidus (mâmaki), and Heliocarpus popayanensis (moho). It main threats at present are competition with alien plants (e.g., Heliocarpus), and pig damage if they head upstream into more native habitat.

- **Lobelia koolauensis** (no common name, Campanulaceae, Endangered)— 88+ plants noted; see page 14 for details.

- **Myrsine cf. fosbergii** (kôlea, Myrsinaceae, Candidate) is a branched shrub or small tree up to 4 meters tall, distinguished by its narrowly elliptic leaves 8–13 centimeters long, with the apex long-acuminate and slightly hooked or falcate, and the base attenuate (Wagner et al. 1990). It is endemic to Kaua‘i (Lorence et al. 1995) and the
Koʻolau Mountains of Oʻahu. Bishop Museum vouchers are concentrated in three parts of the Koʻolau: north of OFNWR in the Punaluʻu–Kaluanui summit area at the head of Castle Trail; and south of OFNWR on the summit ranging from ‘Aiea to Moanalua, and at the summit ridge in the vicinity of Kuliʻouʻou (Bishop Museum Herbarium database, accessed 2011). The most recent census estimates 19 populations with 131 to 141 plants (USFWS 2010a). A single specimen approaching but not matching M. fosbergii (see photo and Map 2, p. 54), noted on the crest of a flat, open ridge supporting an example of the Koʻolau Prostrate Metrosideros Community, is more likely a hybrid, with M. fosbergii as one of the parents. Good M. fosbergii generally has narrower leaves than those on the Kïpapa plant, and they always have intense color on their petioles and proximal midribs; in the central Koʻolau the color is either yellow or reddish purple (Joel Lau, pers. comm., 2011).

The native Myrsine complex also deserves further taxonomic study to better understand species limits and hybridization patterns. The plant in question was growing in association with Metrosideros rugosa (lehua papa), Kadua fosbergii (manono), Syzygium sandwicensis (ʻōhiʻa hā), Clidemia hirta (Koster's curse), Sadleria pallida (ʻamaʻu ʻiʻi), Isachne distichophylla (ʻohe), and Dicranopteris linearis (uluhe).

- **Panicum koolauense** (no common name, Poaceae, Species of Concern) is a perennial tussock- or mat-forming grass found on wet, exposed ridgetops and slopes in the central Koʻolau Mountains of Oʻahu (Wagner et al. 1990), and later reported from Mount ‘Eke, West Maui (Herbst & Clayton 1998). Treated in the genus Dichanthelium in Wagner et al. (1990), it has more recently been included in Panicum (Herbst & Clayton 1998; Clayton & Snow 2010; The Plant List website [www.theplantlist.org], accessed September 2011). In the Koʻolau, Panicum koolauense has been collected in the wet summit areas ranging from Kaipapa’u to Punalu’u, Poamoho, Waikāne–Schofield Trail, Kïpapa, ‘Aiea to Hālawa, and Moanalua (Bishop Museum Herbarium database, accessed 2011). No quantitative assessment has been made of the number of populations or individuals in the Koʻolau (USFWS 2010a). During the survey, the grass was occasionally noted in suitable wet, open habitats on moss- or liverwort-covered ridgetops and banks (see Map 3, p. 55), often in association with a species assemblage typical of the Koʻolau Prostrate Metrosideros Community (see pg. 26). The grass was usually noted as scattered clumps, rather than broad mats. Also of note is the presence of Panicum hillebrandianum in the Koʻolau Prostrate Metrosideros Community. Wagner et al. (1990) documents its presence only on Kauaʻi, Molokaʻi, Maui, and Hawaiʻi, thus this is a previously
undocumented new island record for the island of O‘ahu. The two species can be distinguished by their blade dimensions: *P. hillebrandianum* is 2–5 cm long, 4–8 mm wide; *P. koolauense* is 0.7–1.8 cm long, 1–1.8 mm wide, often appearing linear due to its inrolled margins (Wagner et al. 1990). The primary threat to these grasses in their preferred habitat is competition with weeds. Pig rooting would also damage their habitat, but there was no evidence of pig damage during the survey. In March 2010, Ko‘olau Mountains Watershed Partnership staff discovered 10 additional clumps of *P. koolauense* in two locations along the Ko‘olau summit south of the Kipapa Trail above the Waiawa drainage (Scott Lynch, Ko‘olau Mountains Watershed Partnership, pers. comm., 2011).

- **Polyscias gymnocarpa** (‘ohe‘ohe, Araliaceae, Endangered)— Fourteen plants noted; see page 19 for details.
- **Zanthoxylum oahuense** (a‘e, Rutaceae, Proposed Endangered)— Two plants noted; see page 22 for details.

### IIIc. Noteworthy Invertebrate Findings

While none of the three O‘ahu endemic damselflies (*Megalagrion leptodemas*, *M. nigrohamatum* subsp. *nigrolineatum*, *M. oceanicum*) currently proposed for federal Endangered status (USFWS 2011a) were noted during the survey, others were found. One damselfly species noted on dripping, moss-and-liverwort-covered banks on *Sadleria squarrosa* along the upper reaches of Kipapa Trail at 790 meters (2,600 feet) elevation was identified from photographs as *Megalagrion oahuense* (Blackburn, 1884), the O‘ahu Damselfly, by Bishop Museum entomologist David Preston. A subdued dusky red, relatively large species of *Megalagrion*, this is a truly terrestrial species with no requirement for standing water in its life cycle. The larvae are found in damp leaf litter, usually in *Dicranopteris linearis* (uluhe) patches, and the adults hawk along trails and perch on fern leaves near the trails (D. Preston, pers. comm., 2010). This species is endemic to O‘ahu and was said to be still relatively abundant in the upper Ko‘olau Mountains (Polhemus & Asquith 1996). A second species, tentatively identified from photographs as a female *Megalagrion hawaiense* (McLachlan, 1883), the Hawaiian Upland Damselfly, was noted in native riparian *Metrosideros-Dicranopteris* (‘ōhi‘a-uluhe) shrubland in the headwaters of Kipapa Stream at around 700 meters (2,300 feet) elevation. This species is a seep breeder. They lay their eggs on rheocrene seeps and still side pools along streams, and splash zones near falls also attract them. While not terrestrial in the true sense, they only need the moist substrate provided by the seeps (D. Preston, pers. comm., 2010). This species is the most frequently encountered native damselfly in Hawai‘i, occurring from sea level to at least 1,830 meters (6,000 feet) elevation on Moloka‘i, Lāna‘i, Maui, and Hawai‘i (Polhemus & Asquith 1996). However, on O‘ahu...
and Kaua‘i its range is localized. On O‘ahu, it is restricted mainly to Mount Ka‘ala in the Wai‘anae Mountains, and to
the headwaters of windward slope drainages in the Ko‘olau Mountains (Polhemus & Asquith 1996). While the typical
male coloration throughout its range is red or reddish orange and black, there is color variation, and the original
description was based on specimens from the southeastern Ko‘olau Mountains, where the males exhibited a blue-and-
black color scheme (Polhemus & Asquith 1996). Neither species is currently Federally protected.

IIIId. Weedy Plants of Concern

The survey enumerated 45 taxa of non-native plants. Many of them were relatively innocuous trailside herbs, but four
plants noted during the survey (*Ageratina adenophora*, *Andropogon virginicus*, *Ardisia elliptica*, *Clidemia hirta*) appear
on the Hawai‘i Department of Agriculture List of Plant Species Designated as Noxious Weeds for Eradication or Control
Purposes (Hawaii Administrative Rules, Title 4 Subtitle 6 Chapter 68), which was last updated in June 1992. To merit
inclusion on this list a weed species must meet several criteria involving plant reproduction, growth characteristics,
detrimental effects, necessary control measures, and distribution and spread. Appendix D lists all historical vouchers of
non-native plants collected in the vicinity of the survey area and deposited at Bishop Museum.

Twenty-one of the 45 non-native taxa noted during this survey have been evaluated by the Hawai‘i-Pacific Weed Risk
Assessment (HPWRA), with scores ranging from 28 to -3 (HPWRA 2011). Scores are based on cumulative points given
for a series of questions about the species’ behavior (See Appendix A for further information). A score of 7 or more is
generally considered the point at which a species should be monitored in the field for potentially invasive tendencies. It
should be stressed that the scores only speak to a species’ potential for weediness, and not to its degree of weediness. A
number of factors come into play in assessing the likelihood of an alien plant becoming invasive when introduced into a
novel environment. An extreme example would be to grow a highly invasive water-loving plant in a dry environment,
where it would likely be harmless. As such, it is very possible for a plant with a WRA score of 20+ to be far less of a
management problem than one scored at less than 10. Those with the highest scores (as of August 2011) noted during the
2010 surveys are: 28— *Paspalum conjugatum* (Hilo grass); 21— *Psidium guajava* (common guava); 20— *Andropogon
virginicus* (broomsedge); 18— *Psidium cattleianum* (strawberry guava); 16— *Spathoglottis plicata* (Philippine ground
orchid) and *Axonopus fissifolius* (narrow-leaved carpetgrass); 15— *Pluchea carolinensis* (sourbush); 13— *Schefflera
actinophylla* (octopus tree) and *Sphagneticola trilobata* (wedelia); 11— *Erigeron karvinskianus* (daisy fleabane), *Ardisia
elliptica* (shoebottom ardisia), *Pterolepis glomerata* (false meadow beauty), and *Arundina graminifolia* (bamboo orchid);
10— *Rubus rosifolius* (thimbleberry); 9— *Buddleia asiatica* (butterfly bush); 8— *Falcataria moluccana* (albizia) and
*Angiopteris evecta* (mules-foot fern); and 7— *Centella asiatica* (Asiatic pennywort) and *Heliocarpus popayanensis*
(moho). *Leptospermum scoparium* (New Zealand tea tree) was originally scored at 3, but a second round of screening
questions subsequently revealed its invasive nature (Pacific Islands Ecosystems at Risk 2011). *Cryptomeria japonica*
(sugi pine), which forms several discrete solid patches along the Ko‘olau summit and Kīpapa Trail, scores a non-
threatening -3.
Weedy plants not noted can provide significant clues about the health of an ecosystem. During our surveys in 2010, we did not note invasive species such as *Ageratina riparia* (spreading mist flower), *Cecropia obtusifolia* (trumpet tree), *Citharexylum caudatum* (fiddlewood), *Ficus microcarpa* (Chinese banyan), *Hedychium gardnerianum* (kähili ginger; a management concern, however, in the northeastern section of the refuge), *Melaleuca quinquenervia* (paperbark), *Melinus minutiflora* (molasses grass), *Schinus terebinthifolius* (Christmasberry), *Spathodea campanulata* (African tulip), *Sphaeropteris cooperi* (Australian tree fern), and *Trema orientalis* (gunpowder tree). [Nor were *Cecropia, Ficus, Melaleuca, Melinis, Schinus, Sphaeropteris,* or *Trema* noted in the 2006 OFNWR survey (Imada & LeGrande 2006a)]. While not observing a species during a survey can never guarantee that a species is not present, it does suggest that the species likely occurs in low numbers.

Leech (2006) found that most invasive species stands in the refuge were restricted to below 490 meters (1,600 feet) elevation. Among the species with population size greater than 0.2 hectares (0.5 acres) with a demonstrated ability to form monotypic stands and to spread aggressively or without prior disturbance into intact native forest areas, *Psidium cattleianum* (strawberry guava), *Leptospermum scoparium* (New Zealand tea tree), and *Syzygium jambos* (rose apple) were the most prominent. Also forming monotypic, canopy-dominant stands at lower elevations in the refuge were *Psidium guajava* (common guava), *Falcataaria moluccana* (albizia), *Ardisia elliptica* (shoebutton ardisia), *Heliocarpus popayanensis* (white moho), *Aleurites moluccana* (kukui), and *Andropogon virginicus* (broomsedge) (Leech 2006).

Management of such core populations of invasive species in the refuge zones transitional to the relatively unscathed wet forested uplands should be considered, especially those that are wind- or bird-dispersed and likely to adapt well to the wetter substrates, such as *Ardisia elliptica, Schefflera actinophylla, Psidium cattleianum,* and *Heliocarpus popayanensis.* Control efforts to reduce the density and abundance of these species and their containment within a defined regional area would reduce their spread and impacts.

Data from an ongoing weed control project in O‘ahu Forest National Wildlife Refuge conducted by Ko‘olau Mountains Watershed Partnership (KMWP) was kindly provided by KMWP for the period January 2010 to June 2011 (Scott Lynch, Ko‘olau Mountains Watershed Partnership, pers. comm., 2011), and their kill numbers during that period are included in the profiles presented below. Control work was conducted on 20 targeted invasive taxa, focused on those with potential ecosystem-level impacts, in the relatively undisturbed upper elevation native wet forest section of the refuge, with 2,691 plants killed. Four invasive species comprised 93% of the plants removed: *Leptospermum scoparium* (1,503 killed, 56% of grand total), *Psidium cattleianum* (453 killed, 17%), *Heliocarpus popayanensis* (292 killed, 11%), and *Psidium guajava* (261 killed, 9%). Their distribution is indicated on Map 4 (p. 56) as established invasives with a high priority for removal. Another five species—*Angiopteris evecta, Ardisia crenata, A. elliptica, Falcataaria moluccana,* and *Schefflera actinophylla*—are presently uncommon in the upland native habitat (40 total plants killed, 1.5% of total) but are readily bird- or wind-dispersed, with high potential for successful establishment, and are indicated on Map 4 as incipient invasives with a high priority for removal. Three other species were controlled by KMWP outside the area included on Map 4 (25 plants killed, 1% of total); a single unidentified *Ficus* plant was removed in the lower section of the refuge,
while *Hedychium gardnerianum* and *Solanum mauritianum* (both profiled below) plants were removed from the upper northeastern section. The remaining eight species (118 plants killed, 4.5% of total) controlled by KMWP—*Arundina graminifolia*, *Buddleia asiatica*, *Pluchea carolinensis*, *Lantana camara*, *Melaleuca quinquenervia*, *Syncarpia glomulifera*, *Toona ciliata*, and *Zingiber sp.*—are considered to be less pressing threats, and their points are grouped on Map 4 as incipient/established invasives with moderate priority for control. No doubt the weed surveys and management efforts of the Koʻolau Mountains Watershed Partnership within OFNWR have greatly aided its relative lack of weediness. Map 4 also graphically compares the distribution of rare native plants noted in the refuge during this survey and recent fieldwork by KMWP against the locations where KMWP has removed targeted weeds.

Comments below are provided for all non-native species seen during the 2010 surveys receiving Hawaiʻi-Pacific Weed Risk Assessment (HPWRA) scores of 7 or more, as well as other invasive species not yet profiled by HPWRA. Also profiled are species not seen during the surveys but noted by KMWP in conducting their weed control project in Oʻahu Forest NWR, or by U.S. Fish and Wildlife Service staff, and potential encroachment by invasive plant species not currently reported from the refuge.

- **Ageratina adenophora** (Maui pāmakani, Asteraceae, unrated by HPWRA)— A malodorous, semi-woody erect shrub with rhombic to deltate leaves 4–15 centimeters long, the margins coarsely serrate; and inflorescences in erect terminal cymes with only white disc flowers (Wagner et al. 1990). Maui pāmakani is a prolific seeder that replaces native understory plants, and is on the Hawaiʻi State Department of Agriculture’s noxious weed list. This species was rarely seen; it was noted along the Kipapa contour trail in the vicinity of a small landslide disturbance.

- **Andropogon virginicus** (broomsedge, Poaceae, HPWRA=20)— A fire-adapted, erect bunchgrass up to 100 centimeters tall, forming nearly monotypic stands in open and disturbed, dry to mesic forests and shrubland habitats, especially on ridges and slopes (Wagner et al. 1990), impeding reestablishment of native plant species. It is on the Hawaiʻi State Department of Agriculture noxious weed list. Leech (2006) noted that drier, low elevation ridgelines in the refuge that were historically intensively grazed by cows and goats were now severely eroded and supported little vegetation but *Andropogon*; because it becomes dormant during the rainy season, continued erosion is promoted in these areas. The seeds are wind dispersed. It was occasionally seen during the 2010 surveys, but is not a big concern in wetter upland habitats.

- **Angiopteris evecta** (muleʻs-foot fern, Marattiaceae, HPWRA=8)— A large terrestrial fern with arching, twice-pinnately compound fronds up to 3 meters long, and massive rhizomes up to 1 meter tall (Staples & Herbst 2005). It has readily escaped cultivation and is now naturalized on most of the main Hawaiian Islands in wet valleys, where it overtops surrounding vegetation and is readily wind-dispersed via spores (Staples & Herbst 2005). Not seen during refuge surveys by Imada & LeGrande (2006), one plant was noted and removed by Koʻolau Mountains Watershed Partnership (KMWP) staff during the 2010 survey in the vicinity of the Kipapa Trail, and remains a minor element of the upland environment. Since the beginning of 2010, KMWP found and
removed only three other plants (two in the vicinity of Kipapa Trail, one in the northeastern section of the refuge) (see Map 4, p. 56). Definitely a species to be on the lookout for in upland habitats, and removed when spotted.

- **Ardisia elliptica** (shoebutton ardisia, Myrsinaceae, HPWRA=11)— A branching shrub up to 4 meters tall with alternate, obovate to oblanceolate leaves 6–9 centimeters long, covered with punctate glands; flowers usually 5-lobed, pale lavender; and shiny red (immature) to black (mature), globose fruit 5 millimeters in diameter (Wagner et al. 1990). This shade-tolerant species can rapidly form dense monotypic stands in disturbed mesic and wet lowland forests, preventing the establishment of other species (USFWS 2011a), and the fruit is readily bird-dispersed (Staples et al. 2000). *Ardisia elliptica* is on the Hawai‘i State Department of Agriculture noxious weed list. Leech (2006) noted that the species was most aggressive on wet soils along intermittent streambanks and can become established in undisturbed forest habitat, and that it was common at the lowest elevations in O‘ahu Forest NWR, an observation corroborated by Jason Hanley (USFWS, pers. comm., 2011). A few plants were noted at the summit *Cryptomeria* grove, and should be removed. Ko‘olau Mountains Watershed Partnership staff removed a single 1.5 meter tall plant in March 2011 from the upper southeastern (Waiawa) section of the refuge (see Map 4). Given its bird-dispersed fruit and ability to establish itself without prior habitat disturbance, this is a species to be kept on the watchlist.

- **Arundina graminifolia** (bamboo orchid, Orchidaceae, HPWRA=11)— An erect, terrestrial orchid with reedlike stems up to 2.5 meters tall, and linear-lanceolate, grasslike leaves 8–30 centimeters long; the terminal flowers are pink to rose with a darker lip (Wagner et al. 1990). The tiny seeds are wind-dispersed (Staples et al. 2000). Infrequently noted, not a pressing management concern. Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership staff removed 60 plants from the Waiawa side of the Kipapa Trail.

- **Axonopus fissifolius** (narrow-leaved carpetgrass, Poaceae, HPWRA=16)— A perennial grass forming dense, low mats; the blades flat or folded, linear, 4–15 centimeters long, 3–5 millimeters wide; the inflorescences 5–11 centimeters long, composed of 2–7 slender, divergent racemes, each raceme 3.5–5 centimeters long (Wagner et al. 1990). A species of wet pastures, disturbed wet forests, and bogs, *A. fissifolius* does well in soils with low nitrogen levels, and can outcompete other grasses in wet forests and bogs (USFWS 2011a). Aside from being spread vegetatively by stolons, its dispersal mechanism is undocumented (Staples et al. 2000). This grass is ubiquitous in the refuge in wet, open sites, such as along the Kipapa Trail and in disturbed grassy expanses along the Ko‘olau summit and on canopyless upper elevation ridges, such as those containing the unique Ko‘olau Prostrate *Metrosideros* (‘Ōhi‘a) Community. Its control is problematic.

- **Buddleia asiatica** (dog-tail, Buddlejaceae, HPWRA=9)— A shrub or small tree 1–7 meters tall with oblong to ovate or lanceolate leaves 4–30 centimeters long; and small white flowers in terminal to axillary spikelike inflorescences (Wagner et al. 1990). It ranges from lava and cinder fields to wet forest habitats, and is capable of forming dense thickets (USFWS 2011a), and was infrequently noted in the refuge. Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership staff removed 31 plants scattered throughout the refuge.
• **Centella asiatica** (Asiatic pennywort, Apiaceae, HPWRA=7)— A small, creeping herb rooting at the nodes, with orbicular-reniform leaves 2–6 centimeters long (Wagner et al. 1990). Noted in the understory of the summit Cryptomeria grove.

• **Clidemia hirta** (Koster’s curse, Melastomataceae, unrated by HPWRA)— A noxious, shade-tolerant shrub up to 3 meters tall with ovate leaves 5–16 centimeters long, 5-nerved from the base, upper surface pleated; and fleshy, bluish black, bristly hairy, many-seeded, bird-dispersed fruit 6–9 millimeters long (Wagner et al. 1990). It is ubiquitous throughout the moister parts of the Koʻolau, sometimes forming monotypic stands, shading out native plants and preventing their regeneration. *Clidemia hirta* is included on the Hawaiʻi State Department of Agriculture noxious weed list. It is common in the refuge, but not present in ecosystem-impairing monodominant stands in the native upland habitat. A variety of biological control agents have been released to control this species in the state, with varying results (Conant 2002).

• **Cryptomeria japonica** (sugi pine, Taxodiaceae, HPWRA=-3)— Native to Japan and China, this evergreen tree grows up to 25 meters tall in Hawaiʻi, with spreading, needlelike leaves 12–13 millimeters long, the apex incurved; and globose seed cones 1.5–3 centimeters in diameter (Staples & Herbst 2005). A grove of this aromatic member of the redwood family was encountered along a wind-whipped section of the Koʻolau Summit Trail at 750 meters elevation. Although not markedly expanding its range, the grove provides a sheltered understory habitat for bird roosting and alien plant establishment, such as *Psidium cattleianum* (strawberry guava), *Ardisia elliptica* (shoebuton ardisia), and epiphytic plants of *Schefflera actinophylla* (umbrella tree), and it might be best to eradicate the population. Additional groves of larger trees along the Kīpapa Trail were also noted; their removal is ongoing (Jason Hanley, U.S. Fish and Wildlife Service, pers. comm., 2011)

• **Dendrobium rhombeum** (no common name, Orchidaceae, unrated by HPWRA)— A newly discovered naturalizing epiphytic orchid for the state, Joel Lau reared vegetative canes to flowering for positive identification to *D. rhombeum* Lindl. of the Philippines, which is sometimes lumped into *D. heterocarpum* Lindl. (J. Lau, pers. comm., 2011). The canes were up to 30 centimeters tall, perched on a *Psychotria mariniana* (kōpiko) tree and also noted on *Antidesma platyphylla* (hame) along the Kīpapa Trail in a forest of *Metrosideros polymorpha* (ʻōhiʻa lehua), *Syzygium sandwicense* (ʻōhiʻa hā), and *Dicranopteris linearis* (uluhe). The flowers are cream-colored, with a yellow throat and maroon markings. This discovery continues a trend in the finding of epiphytic cultivated plants, notably orchids
and bromeliads, in wild areas in the state. Polystachya concreta, an epiphytic orchid first noted as naturalizing in the Ko‘olau in 1998 along the Poamoho Trail (Staples et al. 2003), was also noted along this stretch of Kipapa Trail; it has since been vouchered as far south as Kalihi Valley in the Ko‘olau, and in the Wai‘anae at East Makaleha (Bishop Museum Herbarium database, accessed 2011). In 2008, Guzmania lindenii, an epiphytic bromeliad native to northern Peru, was noted on the wet Ko‘olau summit ridge above Kalihi Valley at 800 meters elevation, festooning 3–4 meter tall, moss-and-liverwort-covered Metrosideros polymorpha trees in a 20 meter radius (Frohlich & Lau 2010). The wet forest epiphyte niche has not yet been much filled by alien plant species; field crews need to be mindful to monitor this potential habitat.

- **Erigeron karvinskianus** (daisy fleabane, Asteraceae, HPWRA=11)— A sprawling perennial herb producing numerous branched stem up to 30 centimeters long; the leaves are linear to elliptic, 1–4 centimeters long, the lower leaves often 3-lobed; and the flowering heads are solitary, 20 millimeters in diameter, with 60–70 white ray florets becoming pink with age, and yellow disc florets (Wagner et al. 1990; Herbst & Staples 2005). It grows in moderately wet habitats and spreads rapidly by stem layering to form dense mats, crowding out and displacing ground-level natives (USFWS 2011a). The seeds are also wind dispersed (Staples et al. 2000). Found infrequently during the 2010 survey, and not noted as a current management concern, but its presence on wet banks supporting rare natives such as Lobelia spp. and Labordia hosakana should be monitored.

- **Falcataria moluccana** (albizia, Fabaceae, HPWRA=8)— A very fast-growing, short-lived forestry tree up to 40 meters tall with white to gray bark, forming a layered canopy; feathery, twice pinnately compound leaves; cream or greenish yellow mimosa-type flowers; and flat pods 9–12 centimeters long (Wagner et al. 1990). This species was known as Paraserianthes falcataria in Wagner et al. (1990). The light pods are readily wind dispersed, and proximity to waterways probably allows it to be dispersed aquatically as well (Staples et al. 2000). Its brittle but very large branches can be hazardous during wind and rain storms. Leech (2006) noted that Falcataria moluccana rapidly spreads in areas below 305 meters (1,000 feet) elevation with 2,030–3,810 millimeters (80–150 inches) of annual rainfall. Given its preference for more mesic habitats, it is probably less likely that the species could become well established under much wetter conditions. Still, since the beginning of 2010, Ko‘olau Mountains Watershed Partnership staff noted 15 scattered mature plants in the upland refuge and removed 13 of them (see Map 4, p. 56). No mature trees were seen during our surveys; a sapling along the Kipapa Trail was uprooted. It was also uncommon during the 2005–2006 OFNWR survey (Imada & LeGrande 2006a).

- **Heliocarpus popayanensis** (white moho, Tiliaceae, HPWRA=7)— A fast-growing forestry tree up to 30 meters tall with ovate to cordate, unlobed or shallowly 3-lobed, stellate-pubescent leaves 20–30 centimeters long; and plumose-bristly, wind-dispersed capsules (Wagner et al. 1990). It spreads readily in disturbed wetter mesic forest

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**Fig. 18. Heliocarpus popayanensis removal by KMWP staff.**
habitats, where it can outcompete native vegetation (USFWS 2011a). Leech (2006) noted that *Heliocarpus popayanensis* was rapidly spreading in the refuge along riparian corridors, an observation confirmed during the 2005–2006 OFNWR survey (Imada & LeGrande 2006a). Since the beginning of 2010, Ko’olau Mountains Watershed Partnership staff noted 356 mature trees scattered throughout the wetter portions of the refuge, and killed 292 of them (see Map 4, p. 56). Occasional scattered saplings were noted during the 2010 survey, especially in Kipapa Stream, and attempts were made to destroy individual saplings where noted. This species requires constant monitoring in the refuge, especially since it appears to be widely and freely distributed.

- **Leptospermum scoparium** (New Zealand tea tree, manuka, Myrtaceae, HPWRA=3)— A shrub or small tree up to 5 meters tall with linear-lanceolate to linear-elliptic, sharp-tipped leaves 9–14 millimeters long; 5-petaled, pink or white flowers; and 5-valved woody capsules 5–6 millimeters in diameter (Wagner et al. 1990). Native to New Zealand and Australia, in Hawai‘i it occurs in disturbed, mesic to wet forest habitats, forming thickets that aggressively crowd out other plants and also produce allelopathic chemicals that inhibit the growth of other plants (USFWS 2011a). The dustlike seeds are wind dispersed (Staples et al. 2000). Infestations in the Ko’olau Mountains occur at Kawailoa, Poamoho, and Waimano and Manana Trails (Starr et al. 2003c). Manuka is a big management problem in the vicinity of the Manuka Base Camp/Landing Zone and heading up the Kipapa Trail; since the beginning of 2010, Ko’olau Mountains Watershed Partnership staff removed 1,503 plants in aiding ongoing efforts to manually control this invasive pest (see Map 4).

- **Paspalum conjugatum** (Hilo grass, Poaceae, HPWRA=28)— A perennial grass forming a dense ground cover with extensive, wiry stolons; the inflorescences usually consist of two subopposite racemes (Wagner et al. 1990). A commonly seen grass of disturbed moist to wet habitats, such as muddy trails, streambanks, and open grassy summits (USFWS 2011a), but not yet noted in the Ko’olau Prostrate *Metrosideros* (‘Ōhi’a) Community. Its weed risk assessment (http://www.hpwra.org/species/paspalum_conjugatum/) cites among its weedy characteristics a broad climatic suitability; shade tolerance; ability to adapt to a wide range of soil conditions; prolific seed production; and ability to reproduce vegetatively and to disperse its seeds by wind, water, and mechanically. Its control is problematic.

- **Pluchea carolinensis** (sourbush, Asteraceae, HPWRA=15)— A many-branched, aromatic shrub up to 4 meters tall with glandular tomentose, dull grayish green, narrowly ovate to oblong-obovate leaves 5–20 centimeters long; flat-topped inflorescences with pinkish lavender disk flowers; and brownish white pappus (Wagner et al. 1990). This species was known as *P. symphytifolia* in Wagner et al. (1990). Readily wind-dispersed, *P. carolinensis* is usually found in relatively dry coastal areas, but ranges up to 900 meters (3,000 feet) elevation in mesic to wet forest (USFWS 2011a). It was only infrequently seen during the survey. Since the beginning of 2010, Ko’olau Mountains Watershed Partnership staff removed 18 scattered plants in the upland portion of the refuge.

- **Psidium cattleianum** (strawberry guava, waiawï, Myrtaceae, HPWRA=18)— A shrub or small tree 2–6 meters tall, with attractive smooth, peeling bark; leathery, shiny dark green, obovate to elliptic-ovobvate leaves 3.5–13.5 centimeters long; and fleshy red or yellow, globose to obovoid or ellipsoid berries 2–3 centimeters in diameter
O‘ahu Forest National Wildlife Refuge Botanical Survey

(Wagner et al. 1990). Strawberry guava is one of the most intractable of mesic and wet forest noxious pests, forming dense monotypic stands and displacing native vegetation through competition and allelopathic properties. The fruit is eaten by pigs and birds that disperse the seeds throughout the forest (USFWS 2011a). *Psidium cattleianum* was a relatively uncommon element in the upper native forest zone areas surveyed, as was the case in the 2005–2006 OFNWR survey (Imada & LeGrande 2006a). Since the beginning of 2010, though, Ko‘olau Mountains Watershed Partnership staff removed 453 plants and noted 78 other plants that needed treatment in this zone (see Map 4, p. 56), so there are still stands of this invasive to be dealt with in the refuge. Uowolo & Denslow (2008) found that strawberry guava seeds had high germination rates immediately following fruit drop in lowland wet forest soils, but by 196 days (6.5 months) later, no seeds remained viable. They attributed this lack of a persistent seed bank to a combination of rapid, high germination rates; post-dispersal seed predation; and rapid loss of seed viability. As a management practice, they recommended waiting at least three months after the conclusion of fruiting season before conducting chemical or mechanical control of stands, by which time the vast majority of seeds would have either germinated or died. Recent efforts to release a biocontrol agent (a Brazilian scale, *Tectococcus ovatus*) for strawberry guava in the state provide some hope for eventually harnessing the spread of this weed statewide (for more information visit: http://www.fs.fed.us/psw/programs/ipif/strawberryguava/biocontrol.shtml#anchor.3).

- **Psidium guajava** (common guava, Myrtaceae, HPWRA=21)— A shrub to small tree up to 10 meters tall, with smooth, peeling bark; dull green, elliptic to oblong-elliptic leaves 6–15 centimeters long with impressed venation; and globose yellow berries 3–10 centimeters in diameter (Wagner et al. 1990). Common guava can form dense stands in disturbed dry to wet forest habitats. The seeds are spread by feral pigs and alien birds, facilitating competition with native plants (USFWS 2011a). Leech (2006) called common guava the most locally dominant alien species in the refuge, where it forms large monotypic stands along riparian corridors, and consideration should be given to controlling these stands, which serve as source populations for its spread to less disturbed upland habitats. It was an uncommon element during the 2010 survey, which was focused primarily on ridges and slopes. Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership staff removed 261 plants, most of them in stands (see Map 4).

- **Pterolepis glomerata** (false meadow beauty, Melastomataceae, HPWRA=11)— An erect herb up to 50 centimeters tall, with ovate to oblong-ovate or elliptic, 3-nerved leaves 1.4–4.5 centimeters long, both surfaces hairy; and pink, 4-petaled flowers in a hypanthium covered with stellate or branched hairs (Wagner et al. 1990). False meadow beauty is a ubiquitous trailside weed in open, disturbed, mesic to wet habitats. Although seemingly innocuous, it displays many invasive characters, such as a high germination rate, rapid growth, early maturity, ability of fragments to root, and seed dispersal by birds, and can displace native vegetation through competition (USFWS 2011a). It could eventually pose problems in habitats such as the Ko‘olau Prostrate *Metrosideros* (‘Ōhi’a) Community.

- **Rubus rosifolius** (thimbleberry, Rosaceae, HPWRA=10)— A shrub with erect, arching, or trailing stems 10–20 decimeters long with recurved prickles; pinnately compound leaves with usually 7 leaflets, the margins doubly
serrate; 5-petaled white flowers; and red, subglobose fruit 2–3.5 centimeters long (Wagner et al. 1990). It can form dense, prickly thickets in disturbed, mesic to wet forest habitat. Thimbleberry can reproduce from roots left in the ground, and the red fruit are eaten and spread by birds and feral animals (USFWS 2011a). This species was not a common component of the vegetation in areas covered by the 2010 survey.

- **Sacciolepis indica** (Glenwood grass, Poaceae, unrated by HPWRA)— Native to the Paleotropics, this slender grass has a spikelike, cylindrical inflorescence 1.5–7 centimeters long and less than 5 millimeters in diameter, and is a common grass along trails and in open, wet areas such as grasslands, ridge crests, and in openings of wet forest (Wagner et al. 1990), often growing with *Axonopus fissifolius* or *Paspalum conjugatum*. It may be most problematic in habitats such as the Koʻolau Prostrate *Metrosideros* (ʻŌhiʻa) Community, but *Axonopus* is a bigger threat.

- **Schefflera actinophylla** (octopus tree, Araliaceae, HPWRA=13)— Native to Australia and New Guinea, octopus tree is a widely cultivated tree 10–15 meters tall with large, palmately compound leaves with 5–18 leaflets; and inflorescences of radiating, pinkish red, umbrella-spokelike branches 40–80 centimeters long (Wagner et al. 1990). This fast-growing, shade-tolerant tree is readily dispersed by fruit-eating birds and usually occurs in low-elevation, disturbed mesic habitats, forming dense thickets, but can also invade undisturbed native forests (USFWS 2011a). Infrequently noted during the survey as a terrestrial plant; it was more often noted as an epiphyte on trees along Kïpapa Trail, and in the summit *Cryptomeria* grove. It was not noted during the 2005–2006 OFNWR survey (Imada & LeGrande 2006a). Since the beginning of 2010, Koʻolau Mountains Watershed Partnership staff removed 20 plants (including 11 immatures) scattered throughout the upper elevation part of the refuge (see Map 4, p. 56). All plants seen should be killed, and consideration should be given to controlling populations in more infested portions of the refuge at lower elevations.

- **Sphagneticola trilobata** (wedelia, Asteraceae, HPWRA=13)— A commonly cultivated, creeping, mat-forming perennial herb rooting at the nodes; the leaves are fleshy, 4–9 centimeters long, irregularly toothed or serrate, usually with a pair of lateral lobes; and the flowers have 8–13 yellow ray petals (Wagner et al. 1990). Trailside patches were seen along the Kïpapa Trail. Owing to its vigorous vegetative reproduction and ability to form monocultures, its removal is recommended before it finds its way into fragile habitats in the refuge. Weed-whacking is not recommended, as the species reproduces vegetatively (Staples et al. 2000) and the fragments are likely to be scattered and can readily root themselves. Also, management staff should be aware that handling wedelia can cause itching and contact dermatitis (Staples & Herbst 2005).

- **Spathoglottis plicata** (Philippine ground orchid, Orchidaceae, HPWRA=16)— An erect, terrestrial orchid 3–15 decimeters tall, with linear-lanceolate, conspicuously pleated leaves 20–150 centimeters long emerging from pseudobulbs; and dark purple to pale pink flowers arranged along an erect stalk emerging from the pseudobulb (Wagner et al. 1990). The seeds are wind dispersed (Staples et al. 2000). Noted, but not considered a problem weed in the refuge.

Non-native plant discoveries in the refuge not seen during the survey but brought to our attention are discussed below:
• **Ardisia crenata** (Hilo holly, Myrsinaceae, HPWRA=10)— A small erect shrub up to 1.5 meters tall with alternate, elliptic-lanceolate to oblanceolate leaves 6–20 centimeters long, the margins revolute, crisped, and undulate (Wagner et al. 1990). An escape from cultivation, *A. crenata* is readily dispersed by birds attracted to its round, dark shiny red, fleshy, pea-sized fruit. Since the beginning of 2010, Ko’olau Mountains Watershed Partnership (KMWP) staff has removed single plants from along the Kipapa Trail (see Map 4, p. 56) and in the northeastern portion near Pu‘u Ka‘aumakua (Scott Lynch, KMWP, pers. comm., 2011). It has been observed as scattered individuals in the summit area above Kalauoa Valley at 685 meters (2,250 feet) elevation (Imada & LeGrande 2006a) and to the windward side of O‘ahu Forest NWR in the back of Wai‘ahole to Kahana Valleys (Bishop Museum Herbarium database, accessed 2011). Although not seemingly in the class of its relative, *A. elliptica*, as a habitat disruptor, plants should be removed as they are located.

• **Hedychium gardnerianum** (kähi ginger, Zingiberaceae, HPWRA=16)— Large herb with leafy shoots 1–2 meters long; leaves distichous, ovate-elliptic, 20–45 centimeters long; inflorescences erect, cylindrical, 16–30 centimeters long, flowers greenish yellow to yellow-orange, stamens prominent, bright reddish orange; and seeds red, 5–6 millimeters long (Wagner et al. 1990). This aggressive invader of native rainforests forms dense mats of underground rhizomes that crowd out other plants and prevents natural regeneration (Staples & Cowie 2001). Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership (KMWP) staff has killed 22 plants but with 488 mature plants still needing to be removed, solely concentrated in the upper northeastern corner of the refuge. Continued effort should be made to remove remaining plants.

• **Lantana camara** (lantana, Verbenaceae, HPWRA=21)— Pungent, branched shrub 2–3 meters tall, covered with stout recurved prickles; leaves ovate to oblong, 2–12 centimeters long, conspicuously reticulate-rugose, scabrous; and flowers in heads, corollas ranging from yellow, orange, rose, pink, orange, to reddish orange, changing with age (Wagner et al. 1990). Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership (KMWP) staff removed a single plant from the summit area at the Waiawa end of the refuge. This species is more of a problem in drier habitats.

• **Melaleuca quinquenervia** (paperbark, Myrtaceae, HPWRA=15)— Tree to 20–25 meters tall, with whitish or pale brown, exfoliating bark; leathery, lanceolate to oblanceolate, glandular-punctate leaves 5–9 centimeters long; and creamy white, bottlebrush-type inflorescences 3–10 centimeters long (Wagner et al. 1990). A common forestry planting in the state, it is now naturalized mostly in disturbed mesic forest (Wagner et al. 1990). Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership (KMWP) staff removed two isolated plants in the upper elevation part of the refuge.

• **Passiflora tarminiana** (banana pokā, Passifloraceae, HPWRA=24)— Liana; blades deeply 3-lobed, 6–16 centimeters long, softly hairy on lower or both surfaces; flowers pendent, 6–9 centimeters in diameter, sepals and petals pink; and berries yellow when ripe, obovate to oblong, 6–8 centimeters long (Wagner et al. 1990). In Wagner et al. (1990), the species was known as *P. mollissima*. *Passiflora tarminiana* is on the Hawai‘i State Department of Agriculture noxious weed list. Two plants were apparently identified and destroyed in the refuge in 2011 by U.S. Fish and Wildlife Service staff, although details were unavailable at the time this report was...
being completed. Banana poka has never previously been reported from O‘ahu, so this report must be taken seriously, as this invasive vine has blanketed trees on thousands of acres of mesic forest on Kaua‘i and Hawai‘i (Starr et al. 2003e). The fleshy fruit is bird- or mammal-dispersed. The observation locality and perimeter should be scoured periodically for additional plants, in collaboration with the O‘ahu Invasive Species Committee.

- **Solanum mauritianum** (pua nānā honua, Solanaceae, HPWRA=24)— Shrub or small tree 2–4 meters tall forming a rounded canopy, all parts densely pubescent with stellate hairs; leaves elliptic, up to 30 centimeters long; corolla lilac blue, 5-lobed; and berries dull yellow, globose, 1–1.5 centimeters in diameter (Wagner et al. 1990). Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership (KMWP) staff removed two plants along the summit ridge near Pu‘u Ka‘aumakua in the upper northeastern corner of the refuge. This species appears to have some potential to become a troublesome weed in the upper elevation Ko‘olau, as it seems to be working its way up into wetter habitats over time.

- **Sphaeropteris cooperi** (Australian tree fern, Cyatheaceae, HPWRA=8)— A tree fern with a slender, erect caudex usually 1–2 meters tall; fronds up to 4+ meters long, blades bipinnately compound; and stipe bases and fiddleheads covered with loosely attached scales of two types (Palmer 2003). It can be readily distinguished from a native *Cibotium* tree fern by the narrower “trunk” and the presence of scales (*Cibotium* has hairs, but no scales) (Palmer 2003). This shade-tolerant, fast-growing species aggressively spreads via wind-dispersed spores, displacing native understory vegetation in a variety of habitats. Jason Hanley (USFWS, pers. comm., 2011) reported its presence in the lower part of the refuge during the summer of 2011.

- **Syzygium jambos** (rose apple, Myrtaceae, unrated by HPWRA)— A tree 6–15 meters tall with narrowly lanceolate leaves 10–23 centimeters long; flowers dominated by creamy white filaments 10–50 millimeters long; and subglobose yellow berries 2–4 centimeters long (Wagner et al. 1990). Leech (2006) noted that in O‘ahu Forest NWR, it occurred in large, dense stands in the northwestern part of the refuge, but these stands may no longer be present. In April 2005, a new rust fungus, *Puccinia psidii*, was detected in Hawai‘i (Loope 2010). Originally described in 1884 on *Psidium guajava* (common guava) in Brazil, this rust is now known to have a broad host range in the family Myrtaceae, which in Hawai‘i includes the genus *Metrosideros*, the backbone of our forested watersheds. Thus, its presence has been a cause for much concern. The single genetic strain present in Hawai‘i has not attacked many species known to be infected by the rust elsewhere, such as *Psidium guajava*, and its effect on *Metrosideros* has likewise thankfully been mild. On the other hand, it has severely damaged populations of the federally Endangered Hawaiian endemic, *Eugenia koolauensis*, and devastated vast stands of *Syzygium jambos*, with widespread crown dieback and often complete tree death (Loope 2010). The arrival of new genetic strains of *Puccinia psidii* has the same potential to devastate large tracts of *Metrosideros*-dominated forest in the state.

- **Toona ciliata** (Australian red cedar, Meliaceae, HPWRA=2)— Fast-growing tree 20–30 meters tall; leaves pinnately compound, 3–6 decimeters long, with 10–14 leaflets, each 4.5–16 centimeters long; and capsules thinly woody, reddish brown, ellipsoid, 2–2.8 centimeters long, opening by 5 valves (Wagner et al. 1990). This
was a commonly planted forestry tree in the state, but not much noted escaping into upland native forests. Since the beginning of 2010, Ko‘olau Mountains Watershed Partnership (KMWP) staff removed three scattered plants in the southeastern corner of the refuge. One to keep tabs on.

Some invasive species monitored by the O‘ahu Invasive Species Committee have not yet been collected inside the borders of OFNWR, but are noted here to remind refuge management staff of their presence just outside the refuge boundaries. They include:

- **Acacia mangium** (mangium, Fabaceae, HPWRA=8)— Native to Queensland, Australia, the Molucca Islands, Papua New Guinea, and Indonesia, *A. mangium* is a spreading, fast-growing tree up to 30 meters tall, with broad phyllodes 5–10 centimeters wide, inflorescences in spikes of white to cream-colored flower heads, and coiled pods. It has a history of being introduced as a forestry tree, then naturalizing, as documented in the Cook Islands, Palau, Saipan, and Pohnpei (Starr et al. 2003a; Frohlich & Lau 2008). In Hawai‘i it has been rarely cultivated as a forestry planting, or in agricultural experiment stations or botanical gardens, and is now naturalizing in the Kahuku Training Area (where 150–200 mature planted trees and 200+ seedlings were noted in 2003, and in Kāne‘ohe on O‘ahu). *Acacia mangium* can be distinguished from the similar *A. auriculiformis* (also documented as naturalizing on O‘ahu) by its phyllodes with prominently reticulate secondary veins (not prominent in *A. auriculiformis*), white to cream-colored spikes (yellow in *A. auriculiformis*), and pubescent calyx (glabrous in *A. auriculiformis*) (Frohlich & Lau 2008). Four plants (2 mature, 2 immature) were recently noted and removed by the O‘ahu Invasive Species Committee oceanward of the head of Kïpapa Trail between 275 and 335 meters elevation (Rachel Neville, O‘ahu Invasive Species Committee, pers. comm., 2011).

- **Cortaderia selloana** (pampas grass, Poaceae, HPWRA=24)— Native to Argentina, southern Brazil, and Uruguay, pampas grass is a clumping grass up to 3 meters tall with narrow, sharp-edged leaf blades 1–2 meters long; and whitish, cream, pink, to purplish, wind-dispersed inflorescence plumes 1 meter long (Staples & Herbst 2005). It is widely cultivated worldwide as an ornamental grass, but its invasive tendencies have been well documented (Starr et al. 2003b). On O‘ahu, it has been historically cultivated as an ornamental (Bishop Museum Herbarium database, accessed 2011), and was thought to be relatively harmless because only female plants were being cultivated in Hawai‘i (Staples et al. 2005), but it is apparently no longer the case. It was first documented as naturalizing on O‘ahu in October 2008 on the access road approach to the start of the Kïpapa Trail, in a *Melaleuca* forested area, where a single mature individual with a dehisced inflorescence and two immature plants were seen sprouting through *Dicranopteris linearis* (‘uluhe) substrate (Frohlich & Lau 2010). Starr et al. (2003b) record the flowering time for *C. selloana* in Hawai‘i as occurring from mid-September to mid-November. A related species, *C. jubata*, was found to be naturalizing on the slopes of Haleakala, Maui in 1987; it can be distinguished vegetatively from *C. selloana* by the abundant hairs on the culm sheaths and outside of the leaf sheaths in *C. jubata* (versus glabrous in *C. selloana*) (Staples & Herbst 2005). *Cortaderia jubata* is currently on the Hawai‘i State Department of Agriculture’s noxious weed list; *C. selloana* is not.
• **Melochia umbellata** (melochia, Sterculiaceae, HPWRA=7)— Native from India to southwestern Asia and Malesia to New Guinea, *M. umbellata* is a small tree up to 15 meters tall, with broadly ovate, stellate pubescent leaves 9–30 centimeters long; flowers in open cymes, the petals pale pink to red, 6–7 millimeters long; and capsules oblong, deeply grooved, green, brown, or purplish red, 8–10 millimeters long (Wagner et al. 1990). Long-cultivated in the state, the first naturalized population was recorded from the Big Island following aerial seeding in the Waiakea area after a fire in 1928 (Wagner et al. 1990). It has since been documented as naturalizing on Maui (Oppenheimer 2004) and O‘ahu, where it was collected from the Kahuku Training Area in 2003 near the summit between ‘Ō‘io and ‘Ōhi’a Gulches at 457 meters elevation, from a population of 10–20 mature trees with up to 400 smaller immature plants (Frohlich & Lau 2007). It is wind-dispersed via winged seeds; Starr et al. (2003d) document its invasive history in Hawai‘i and elsewhere. One mature individual was recently noted and removed by the O‘ahu Invasive Species Committee (OISC) on a ridge south of the head of Kipapa Trail at about 300 meters elevation, about 0.6 kilometers from the *Cortaderia* site; another nearby site where OISC has removed plants is at the southern end of Wai‘āhole Valley at about 125 meters elevation in windward O‘ahu (Rachel Neville, O‘ahu Invasive Species Committee, pers. comm., 2011). In the northern Ko‘olau, U.S. Army Natural Resources is continuing to manage *Melochia* at Kahuku Training Area, and a large population is naturalized in Punalu‘u Valley (O‘ahu Invasive Species Committee 2008).

• **Miconia calvescens** (miconia, Melastomataceae, HPWRA=14)— A tree 4–15 meters tall with elliptic-oblong leaves up to 80 centimeters long, strongly 3-nerved, velvety green above, dark purple or red below (Medeiros et al. 1997; Staples & Herbst 2005). On the Hawai‘i State Department of Agriculture’s noxious weed list, miconia is considered potentially the most invasive and damaging weed of rainforests in the state, and its control efforts have been well publicized. On O‘ahu, coordinated control efforts have been ongoing since the early 1990s, with attention to outbreaks in Mānoa, Kalihi, Nu‘uanu, and Kahalu‘u (Medeiros et al. 1997). Since its formation in 2000, the O‘ahu Invasive Species Committee (OISC) has been at the forefront of invasive species eradication efforts on the island, and the Kahalu‘u area had already been a known source of miconia plantings and escapes, with ongoing OISC monitoring. In 2009, three new mature trees and numerous juvenile plants of miconia were discovered in the back of Ka‘alaea Valley, located between Wai‘āhole and Waihe’e Valleys, windward O‘ahu, southeast of the southern border of the refuge (O‘ahu Invasive Species Committee 2009). This population is close enough to O‘ahu Forest NWR for a bird-dispersed seed to potentially find its way there, and is definitely a species for which to be on the lookout.

• **Tibouchina herbacea** (cane tibouchina, Melastomataceae, HPWRA=24)— An herb or subshrub up to 1 meter tall, with square stems densely covered with gland-tipped hairs; ovate to oblong-ovate leaves 3–7.5 centimeters long, both surfaces strigose; and flowers with 4 petals, each 6–11 millimeters long (Wagner et al. 1990). *Tibouchina herbacea* is on the Hawai‘i State Department of Agriculture’s noxious weed list. On O‘ahu, it was first noted in 2005 by a crew from the O‘ahu Invasive Species Committee, in the vicinity of the H-3 tunnel in Hālawa Valley in the company of outplanted *Cibotium* (hāpu‘u) tree ferns and a second alien weed previously uncollected on O‘ahu, *Rubus ellipticus* var. *obcordatus* (Frohlich & Lau 2007). It then became apparent that the
Cibotium plants were imported from Hawai‘i Island, since it was the only island on which both the Tibouchina and the Rubus species were naturalized. All of the Tibouchina plants were eradicated at that time. In 2008, the U.S. Army Environmental crew found and destroyed a sprawling T. herbacea plant with multiple canes along the Ko‘olau summit trail south of the Poamoho summit (M. Walker USARMY 97, M. Keir & S. Heitzman USARMY 98; specimens at Bishop Museum). While it was not fertile at the time, its size suggested that it had probably been there for several years. Subsequently, a few additional plants have been found in the vicinity, including one with spent fruits (O‘ahu Invasive Species Committee 2010). In May 2011, two vegetative plants were seen and pulled up along the dirt road leading to the Poamoho trailhead (Neal Evenhuis, Bishop Museum, pers. comm., 2011); unfortunately, neither plant was recovered as a voucher.

IV. RECOMMENDATIONS

- Continued rare plant surveys in the refuge are highly recommended, as there remains high potential for additional discoveries. Especially given the extreme terrain presented by the refuge and the time limitations of each survey project, 100 percent coverage is never possible, and repeat visits to ground already covered will sometimes reveal rare species not noted in previous visits. In addition, there remain large tracts of O‘ahu Forest NWR that are yet to be explored botanically for rare plants.

- Regular monitoring of the Lobelia koolauensis/audichaudii populations should be undertaken so that their identities can be determined. Verification has implications for future conservation efforts in the refuge, since L. koolauensis is federally listed as Endangered, while L. audichaudii presently has no Federal protection.

- Weed management efforts should continue to concentrate on invasive, readily dispersible canopy species that are not yet established in this section of the refuge, such as Angiopteris evecta (mule’s-foot fern), Ardisia elliptica (shoebottom ardisia), Falcataria moluccana (albizia), Heliocarpus popayanensis (white moho, occasionally noted), Psidium cattleianum (strawberry guava), and Schefflera actinophylla (octopus tree).

- Continue efforts to manage the Leptospermum scoparium infestation along Kïpapa Trail.

- Continue to implement tool and gear hygiene to limit the spread of species along trails and into new areas.

- Management of core populations of invasive species in the refuge zones transitional to the relatively unscathed wet forested uplands should be considered, especially those that are wind- or bird-dispersed and likely to adapt well to the wetter substrates. Control efforts to reduce the density and abundance of these species and their containment within a defined regional area will reduce the spread and impacts of these species, which could include Ardisia elliptica, Schefflera actinophylla, Psidium cattleianum, and Heliocarpus popayanensis.
• Continue to monitor the area in which *Passiflora tarminiana* was reportedly discovered in the refuge in 2011.

• Remove the grove of *Cryptomeria japonica* (sugi pine) along the Ko‘olau summit.

• Conduct invertebrate surveys in the refuge, especially with regard to native damselfly populations.

• Continue to monitor pig activity in the refuge, which is presently concentrated at lower elevations. If pig activity starts trending toward higher elevations, consider fencing of fragile habitats, such as the Ko‘olau Prostrate *Metrosideros* Community.

• Consider monitoring of known rare plant locations for the purposes of seed collection, with deposit of material in the seed bank at Harold L. Lyon Arboretum.

• Support should be extended to scientists conducting taxonomic research on Hawaiian endemic plants and invertebrates. It is apparent from current field studies that, in the wake of the landmark publication of the *Manual of the Flowering Plants of Hawai‘i* (Wagner et al. 1990), a number of Hawaiian genera need taxonomic overhauls (J. Lau, pers. comm.); this report itself calls for more careful study in *Melicope*, *Metrosideros*, and *Myrsine*. Such studies would likely result in an increase in the number of rare taxa reported in O‘ahu Forest National Wildlife Refuge.

V. ACKNOWLEDGMENTS

A big mahalo for the field acumen and fellowship of our excellent field crew, which, besides the authors of this report, included George Akau, B.J. Davis, Scott Lynch, Paul Roman, and Adam Williams (Ko‘olau Mountains Watershed Partnership); Jason Hanley, Cheryl Phillipson, and Matt Stelmach (U.S. Fish and Wildlife Service); Danielle Frohlich and Alex Lau (O‘ahu Invasive Species Committee/O‘ahu Early Detection); and Dr. Shelley James (Bishop Museum). The Hawai‘i Invasive Species Council is thanked for supporting the participation of Patti Clifford during this project; Patti took part in the January 2010 campout, provided GIS expertise and training, advised on the Weedy Plants of Concern section, played a major role in the creation and production of the field identification cards, and created the excellent maps included in this report. To Pacific Helicopters pilots Howard Esterbrook and Lincoln Ishii, mahalo for safely and efficiently getting the field crews and slingloads in and out each and every time. Aloha to the U.S. Fish and Wildlife Service’s Jason Hanley (Invasive Species Strike Team Leader, Hawai‘i and Pacific Islands National Wildlife Refuge Complex) and Dave Ellis (Project Leader, O‘ahu National Wildlife Refuge Complex) and Miranda Smith (past Coordinator, Ko‘olau Mountains Watershed Partnership) for fostering and helping to coordinate the field surveys, and to Rachel Neville (Coordinator, O‘ahu Invasive Species Committee) for allowing the participation of Danielle and Alex, and for providing data on invasive species in the vicinity of O‘ahu Forest NWR. David Preston, Bishop Museum entomologist, is thanked for providing damselfly identifications.
Photo credits:
Danielle Frohlich: Fig. 1 (Sadleria squarrosa), Fig. 10 (Labordia hosakana), Fig. 17 (Dendrobium rhombeum)
Clyde Imada: Fig. 3 (Euphorbia rockii), Fig. 4 (Labelia koolauensis), Fig. 5 (Polyscias gymnocarpa), Fig. 9 (Metrosideros bog detail), Fig. 12 (Myrsine cf. fosbergii), Fig. 16 (Cryptomeria japonica), Fig. 18 (Heliocarpus popayanensis)
Koolau Mountains Watershed Partnership: Fig. 2 (Cyanea koolauensis), Fig. 6 (Zanthoxylum oahuense), Fig. 7 (upland ridges shot), Fig. 11 (Lobelia hypoleuca), Fig. 13 (Panicum koolauense), Fig. 15 (Megalagrion hawaiense)
Alex Lau: Lobelia koolauensis cover shot, Fig. 8 (Metrosideros bog uphill shot), Fig. 14 (Megalagrion oahuense)

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### VII. SPECIES ACRONYMS USED IN MAP LEGEND

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<td>LEPSCO</td>
<td>Leptospermum scoparium</td>
<td>New Zealand tea tree, manuka</td>
</tr>
<tr>
<td>LOBHYP</td>
<td>Lobelia hypoeluca</td>
<td>kuhi’aikamo’owahie</td>
</tr>
<tr>
<td>LOBKOO</td>
<td>Lobelia koolauensis</td>
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</tr>
<tr>
<td>LOBSP</td>
<td>Lobelia species</td>
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<tr>
<td>MYRFOS</td>
<td>Myrsine fosbergii</td>
<td>kōlea</td>
</tr>
<tr>
<td>POLGYM</td>
<td>Polyscias gymnocarpa</td>
<td>‘ohe‘ohe</td>
</tr>
<tr>
<td>PSICAT</td>
<td>Psidium cattleianum</td>
<td>strawberry guava, waiawī ‘ula‘ula</td>
</tr>
<tr>
<td>PSIGUA</td>
<td>Psidium guajava</td>
<td>common guava</td>
</tr>
<tr>
<td>SCHACT</td>
<td>Schefflera actinopbylla</td>
<td>octopus tree, umbrella tree</td>
</tr>
<tr>
<td>ZANOAH</td>
<td>Zanthoxylum oahuense</td>
<td>a‘e, mānele</td>
</tr>
</tbody>
</table>
Map 1. Oahu Forest NWR Location Map and Survey Coverage

Legend
- Survey areas 2003 & 2005
- Survey area 2010
- Oahu Forest NWR

NAD 1983 UTM zone 4N
Species survey (2005 & 2010) Bishop Museum
Map date: 8/9/2011
Produced at the Bishop Museum
Map 4. Rare and Invasive Plant Taxa Occurrences

Legend
- Threatened and Endangered Species
- Incipient Invasives - High priority
  - ANHEVE
  - ARDCRE
  - ARDELL
  - FALMOL
  - SHACT
- Established Invasives - High priority
  - HELPOP
  - LEPSCO
  - PSICAT
  - PSIGUA
- Incipient/Established - Moderate priority
  - Represents 11 species
  - Tracklog
- Refuge Boundary

Produced at the Bishop Museum
Honolulu, HI
Land status current to: 10/15/2010
Map date: 9/29/2011
UTM zone 4N
NAD 83

Bishop Museum 56 Hawaii Biological Survey
APPENDIX A: O‘ahu Forest National Wildlife Refuge Vascular Plant Checklist

The following is a list of vascular plant taxa noted during the O‘ahu Forest National Wildlife Refuge plant survey conducted on 11–13 January and 12–15 October, 2010. A total of 165 taxa were noted during the survey, including 105 endemic, 14 indigenous (including “ind?”), 43 naturalized, and 3 Polynesian-introduced (including “pol?”) plants. Thus, about 72% (119 of 165) of taxa seen were native.

The species list below is divided into four main groups: dicots, monocots, gymnosperms, and pteridophytes. Within each group, plants are arranged alphabetically by family, genus, and species. Each entry includes scientific name with author citation, biogeographic status, common name (if available), Hawai‘i State noxious weed status (Hawaii Department of Agriculture), and, for alien taxa, Hawai‘i-Weed Risk Assessment rating, if available. Taxonomy, status, and common names are generally in accordance with Wagner et al. (1990), Wagner and Herbst (2003), Palmer (2003), or Staples and Herbst (2005); sources for updated scientific names are cited in the text. An explanation of abbreviations used in the list follows.

Noxious Weed Status
An asterisk (*) preceding the scientific name indicates that the species is a noxious weed designated for eradication or control by the Hawai‘i Department of Agriculture (Hawaii Administrative Rules, Title 4 Subtitle 6 Chapter 68). A weed species must meet several criteria involving plant reproduction, growth characteristics, detrimental effects, necessary control measures, and distribution and spread before it can be considered for addition to this list. The list was last updated on 18 June 1992. Four noxious weed species are included in the following checklist: Ageratina adenophora, Andropogon virginicus, Ardisia elliptica, and Clidemia hirta.

Biogeographic Status (from Wagner et al. 1990)

<table>
<thead>
<tr>
<th>Code</th>
<th>Definition</th>
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<tbody>
<tr>
<td>end</td>
<td>Endemic: native, occurring only in the Hawaiian Archipelago</td>
</tr>
<tr>
<td>ind</td>
<td>Indigenous: native, occurring naturally in the archipelago but also outside of Hawai‘i</td>
</tr>
<tr>
<td>ind?</td>
<td>Questionably indigenous: probably indigenous, possibly naturalized</td>
</tr>
<tr>
<td>nat</td>
<td>Naturalized: introduced to the archipelago directly or indirectly by humans since Western contact and reproducing and spreading vegetatively or by seed</td>
</tr>
<tr>
<td>pol</td>
<td>Polynesian introduction: introduced by original Polynesian settlers, either intentionally or unintentionally, and now naturalized</td>
</tr>
<tr>
<td>pol?</td>
<td>Questionably Polynesian-introduced: perhaps introduced by original Polynesian settlers, but possibly introduced in historic times</td>
</tr>
</tbody>
</table>

Federal Endangerment Status

C Candidate: a species under consideration for official listing for which there is sufficient information to support listing.
E  Endangered: any species in danger of extinction throughout all or a significant portion of its range; protected under the U.S. Endangered Species Act of 1973

PE  Proposed Endangered: a species proposed for official listing as Endangered.

SOC  Species of Concern: rare species for which there is currently insufficient evidence on biological status and threats to propose them as Endangered or Threatened

**Weed Risk Assessment (WRA) Score**

The Hawai‘i-Pacific Weed Risk Assessment (HPWRA) is an objective scoring system, adapted from a methodology originally developed in Australia and New Zealand, for identifying plants that have the potential to become invasive in Hawai‘i and other Pacific islands (Denslow & Daehler 2004). The assessment is a predictive model that identifies the risk for a species to become invasive, based on published information, rather than a field-based evaluation of actual ecological or economic harm. The assessment asks 49 questions relating to the degree and extent of cultivation of the species; climate and distribution; whether it has been recorded as a weed elsewhere; undesirable traits (i.e., thorns, toxicity to animals); what type of plant it is (i.e., aquatic, grass, nitrogen fixer); reproductive mechanisms (whether it hybridizes, is self-compatible); dispersal mechanism (water, wind, bird); and any persistence attributes of the species (prolific seed production, seed bank) in an effort to quantify the species’ potential weediness. Scores for assessed plants fall between -14 and 29, with 29 being a very high score (e.g., for a species such as *Salvinia molesta*, which displays many weedy tendencies), and -14 being the lower end of the scale for weediness. A score of 7 or more is generally considered the point at which a species should be monitored in the field for invasive tendencies. Species scoring between 1 and 6 are re-evaluated through a decision tree, resulting in a determination of low or high risk. Species-by-species assessments can be found on the Hawaiian Ecosystems at Risk (HEAR) website at [http://www.hpwra.org/species/](http://www.hpwra.org/species/).


L(HPWRA)  Not currently recognized as invasive in Hawai‘i, and not likely to have major ecological or economic impacts on other Pacific islands, based on the HP-WRA screening process.

L(Hawai‘i)  Not currently recognized as invasive in Hawai‘i, based on a track record of not becoming naturalized despite being widely planted in Hawai‘i for at least 40 years.

H(HPWRA)  Likely to be invasive in Hawai‘i and on other Pacific islands as determined by the HP-WRA screening process, which is based on published sources describing species biology and behavior in Hawai‘i and/or other parts of the world.

H(Hawai‘i)  Documented to cause significant ecological or economic harm in Hawai‘i, as determined from published information on the species’ current impacts in Hawai‘i.
<table>
<thead>
<tr>
<th>FAMILY</th>
<th>FULL NAME</th>
<th>STATUS</th>
<th>COMMON NAME</th>
<th>FED</th>
<th>WRA</th>
<th>WRA DESIG</th>
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<tr>
<td>DICOTS</td>
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<td>Apiaceae</td>
<td>Centella asiatica (L.) Urb.</td>
<td>nat</td>
<td>Asiatic pennywort</td>
<td>7</td>
<td>H (Hawai‘i)</td>
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<tr>
<td>Apocynaceae</td>
<td>Alyxia stellata (J.R.Forst. &amp; G.Forst.) Roem. &amp; Schult.</td>
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<td>maile</td>
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<tr>
<td>Aquifoliaceae</td>
<td>Ilex anomala Hook. &amp; Arn.</td>
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<td>kāwa‘u</td>
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</tr>
<tr>
<td>Araliaceae</td>
<td>Cheirodendron platyphyllum (Hook. &amp; Arn.) Seem. subsp. platyphyllum</td>
<td>end</td>
<td>‘ōlapa, lapalapa</td>
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<tr>
<td>Araliaceae</td>
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<td>end</td>
<td>‘ōlapa, lapalapa</td>
<td></td>
<td></td>
<td></td>
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<td>Araliaceae</td>
<td>Schefflera actinophylla (Endl.) Harms</td>
<td>nat</td>
<td>octopus tree, umbrella tree</td>
<td>13</td>
<td>H</td>
<td>H (Hawai‘i)</td>
</tr>
<tr>
<td>Araliaceae</td>
<td>Polyscias gymnocarpa (Hillebr.) Lowry &amp; G.M.Plunkett</td>
<td>end</td>
<td>‘ohe‘ohe</td>
<td></td>
<td></td>
<td>E</td>
</tr>
<tr>
<td>Araliaceae</td>
<td>Polyscias oahuensis (A. Gray) Lowry &amp; G.M.Plunkett</td>
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<td>‘ohe mauka</td>
<td></td>
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</tr>
<tr>
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<td>*Ageratina adenophora (Spreng.) R.M.King &amp; H.Rob.</td>
<td>nat</td>
<td>Maui pāmakani</td>
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<tr>
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<td>nat</td>
<td>sourbush</td>
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<td>H (Hawai‘i)</td>
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<td>hāhā</td>
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<td>pukiawe</td>
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<td>‘ōhelo, ‘ōhelo kau lā’au</td>
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<td>hame</td>
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<td>Fabaceae</td>
<td>Acacia koa A.Gray</td>
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<td>Fabaceae</td>
<td>Falcata moluccana (Miq.) Barney &amp; J.W.Grimes</td>
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<td>albizia</td>
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<td>end</td>
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<td>Phyllostegia grandiflora (Gaudich.) Benth.</td>
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<td>kāpana</td>
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<td>kāmakahala</td>
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<td>kāmakahala</td>
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<tr>
<td>Loganiaceae</td>
<td>Labordia hosakana (Sherff) W.L.Wagner, D.R.Herbst &amp; Sohmer</td>
<td>end</td>
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<td>kāmakahala</td>
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<td>Cuphea carthagenensis (Jacq.) J.F.Macbr.</td>
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<td>tarweed</td>
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<td>Lythrum maritimum Kunth</td>
<td>ind?</td>
<td>loosestrife, pūkāmole Koster’s curse</td>
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<td>Melastomataceae</td>
<td>Pterolepis glomerata (Rottb.) Miq.</td>
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<tr>
<td>Melastomataceae</td>
<td>*Cidemia hirta (L.) D.Don var. hirta</td>
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<td>*Ardisia elliptica Thunb.</td>
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<td>shoebutton ardisia</td>
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<tr>
<td>Myrsinaceae</td>
<td>Myrsine cf. fosbergii Hosaka</td>
<td>end</td>
<td>kölea</td>
<td>C</td>
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<td>Leptospermum scoparium J.R.Forst. &amp; G.Forst.</td>
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<td>New Zealand tea tree, manuka</td>
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<tr>
<td>Myrtaceae</td>
<td>Metrosideros macropus Hook. &amp; Arn.</td>
<td>end</td>
<td>'ōhi'a, 'ōhi'a lehua</td>
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<tr>
<td>Myrtaceae</td>
<td>Metrosideros polymorpha Gaudich. var. glaberrima (H.Lév.) H.St.John</td>
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<td>'ōhi'a, 'ōhi'a lehua</td>
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<tr>
<td>Myrtaceae</td>
<td>Metrosideros polymorpha Gaudich. var. polymorpha</td>
<td>end</td>
<td>'ōhi'a, 'ōhi'a lehua</td>
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<tr>
<td>Myrtaceae</td>
<td>Metrosideros polymorpha Gaudich. var. pumila (A.Heller) J.W.Dawson &amp; Stemmerm.</td>
<td>end</td>
<td>'ōhi'a, 'ōhi'a lehua</td>
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<tr>
<td>Myrtaceae</td>
<td>Metrosideros rugosa A.Gray</td>
<td>end</td>
<td>lehua papa</td>
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<tr>
<td>Myrtaceae</td>
<td>Metrosideros tremuloides (A.Heller) Knuth</td>
<td>end</td>
<td>lehua 'āhīhi, 'āhīhi</td>
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<tr>
<td>Myrtaceae</td>
<td>Psidium cattleianum Sabine</td>
<td>nat</td>
<td>strawberry guava, waiawī 'ula'ula</td>
<td>18</td>
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<td>H (Hawai'i)</td>
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<tr>
<td>Myrtaceae</td>
<td>Psidium guajava L.</td>
<td>nat</td>
<td>common guava</td>
<td>21</td>
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<td>H (Hawai'i)</td>
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<tr>
<td>Myrtaceae</td>
<td>Syncarpia glomulifera (Sm.) Nied.</td>
<td>nat</td>
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<tr>
<td>Myrtaceae</td>
<td>Syzygium sandwicensis (A.Gray) Nied.</td>
<td>end</td>
<td>'ōhi'a hā</td>
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<td>Onagraceae</td>
<td>Ludwigia octovalvis (Jacq.) P.H.Raven</td>
<td>pol?</td>
<td>primrose willow, kāmole</td>
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<td>Oxalidaceae</td>
<td>Oxalis corniculata L.</td>
<td>pol?</td>
<td>yellow wood sorrel</td>
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<td>Piperaceae</td>
<td>Peperomia ellipticibacca C.DC.</td>
<td>end</td>
<td>'ala’ala wai nui</td>
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<td>Piperaceae</td>
<td>Peperomia latifolia Miq.</td>
<td>end</td>
<td>'ala’ala wai nui</td>
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<td>Piperaceae</td>
<td>Peperomia membranacea Hook. &amp; Arn.</td>
<td>end</td>
<td>'ala’ala wai nui</td>
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<td>Pittosporaceae</td>
<td>Pittosporum glabrum Hook. &amp; Arn.</td>
<td>end</td>
<td>hō’awa</td>
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<td>Plantaginaceae</td>
<td>Plantago pachyphylla A.Gray</td>
<td>end</td>
<td>laukahi kuahiwi</td>
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<td>Rosaceae</td>
<td>Rubus rosifolius Sm.</td>
<td>nat</td>
<td>thimbleberry</td>
<td>10</td>
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<tr>
<td>Rubiaceae</td>
<td>Bobea elatior Gaudich.</td>
<td>end</td>
<td>t’ahakea lau nui</td>
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<tr>
<td>Rubiaceae</td>
<td>Coprosma longifolia A.Gray</td>
<td>end</td>
<td>pilo</td>
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<td>Rubiaceae</td>
<td>Kadua affinis DC.</td>
<td>end</td>
<td>manono</td>
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<td>Rubiaceae</td>
<td>Kadua centranthoides Hook. &amp; Arn.</td>
<td>end</td>
<td>manono</td>
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<tr>
<td>Rubiaceae</td>
<td>Kadua fosbergii (W.L.Wagner &amp; D.R.Herbst) W.L.Wagner &amp; Lorence</td>
<td>end</td>
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<td>Rubiaceae</td>
<td>Psychotria fauriei (H.Lév.) Fosberg</td>
<td>end</td>
<td>köpiko</td>
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<td>Rubiaceae</td>
<td>Psychotria mariniana (Cham. &amp; Schltldl.) Fosberg</td>
<td>end</td>
<td>köpiko</td>
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<tr>
<td>FAMILY</td>
<td>FULL NAME</td>
<td>STATUS</td>
<td>COMMON NAME</td>
<td>FED ST</td>
<td>WRA SCORE</td>
<td>WRA DESIG</td>
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<tr>
<td>Rutaceae</td>
<td><em>Melicope clusiifolia</em> (A.Gray) T.G.Hartley &amp; B.C.Stone</td>
<td>end</td>
<td>alani</td>
<td></td>
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<tr>
<td>Rutaceae</td>
<td><em>Melicope hosakae</em> (H.St.John) W.L.Wagner &amp; R.K.Shannon</td>
<td>end</td>
<td>alani</td>
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<td>Rutaceae</td>
<td><em>Melicope oahuensis</em> (H.Lév.) T.G.Hartley &amp; B.C.Stone</td>
<td>end</td>
<td>alani</td>
<td></td>
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<tr>
<td>Rutaceae</td>
<td><em>Melicope rotundifolia</em> (A.Gray) T.G.Hartley &amp; B.C.Stone</td>
<td>end</td>
<td>alani</td>
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<td>Rutaceae</td>
<td><em>Melicope wawraeana</em> (Rock) T.G.Hartley &amp; B.C.Stone</td>
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<td>alani</td>
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</tr>
<tr>
<td>Rutaceae</td>
<td><em>Melicope sp.</em> (similar to <em>M. hiiakae</em>)</td>
<td>end</td>
<td>alani</td>
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<tr>
<td>Rutaceae</td>
<td><em>Platydesma spathulata</em> (A.Gray) B.C.Stone</td>
<td>end</td>
<td>pilo kea</td>
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<td>Rutaceae</td>
<td><em>Zanthoxylum oahuense</em> Hillebr.</td>
<td>end</td>
<td>a‘e, mānele</td>
<td>PE</td>
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<td>Sapindaceae</td>
<td><em>Dodonaea viscosa</em> Jacq.</td>
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<td>Thymelaeaceae</td>
<td><em>Wikstroemia oahuensis</em> (A.Gray) Rock var. oahuensis</td>
<td>end</td>
<td>‘ākia</td>
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<tr>
<td>Tiliaceae</td>
<td><em>Heliocarpus popayanensis</em> Kunth</td>
<td>nat</td>
<td>moho, white moho</td>
<td>7</td>
<td>H</td>
<td>(HPWRA)</td>
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<tr>
<td>Urticaceae</td>
<td><em>Boehmeria grandis</em> (Hook. &amp; Arn.) A.Heller</td>
<td>end</td>
<td>‘ākūolea</td>
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<tr>
<td>Urticaceae</td>
<td><em>Pipturus albidus</em> (Hook. &amp; Arn.) A.Gray</td>
<td>end</td>
<td>māmaki</td>
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<td>Verbenaceae</td>
<td><em>Stachytarpheta australis</em> Moldenke</td>
<td>nat</td>
<td>ʻōwī, ʻōi</td>
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<tr>
<td>MONOCOTS</td>
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<td>Agavaceae</td>
<td><em>Cordyline fruticosa</em> (L.) A.Chev.</td>
<td>pol</td>
<td>ʻi, ʻi</td>
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<tr>
<td>Arecales</td>
<td><em>Pritchardia martii</em> (Gaudich.) H.Wendl.</td>
<td>end</td>
<td>loulu hiwa, loulu</td>
<td>SOC</td>
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<tr>
<td>Cyperaceae</td>
<td><em>Carex alligata</em> Boott</td>
<td>end</td>
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<td>Cyperaceae</td>
<td><em>Carex wahuensis</em> C.A.Mey. subsp. wahuensis</td>
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<td></td>
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<td>Cyperaceae</td>
<td><em>Kyllinga brevifolia</em> Rottb.</td>
<td>nat</td>
<td>ʻiili’o’opu</td>
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<td>Cyperaceae</td>
<td><em>Machaerina angustifolia</em> (Gaudich.) T.Koyama</td>
<td>ind</td>
<td>ʻuki</td>
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<tr>
<td>Cyperaceae</td>
<td><em>Machaerina mariscoides</em> (Gaudich.) J. Kern subsp. meyenii (Kunth) T.Koyama</td>
<td>end</td>
<td>ʻahaniu, ʻuki</td>
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<tr>
<td>Cyperaceae</td>
<td><em>Rhynchospora caduca</em> Elliott</td>
<td>nat</td>
<td>beak-rush</td>
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<tr>
<td>Cyperaceae</td>
<td><em>Rhynchospora chinensis</em> Nees &amp; Meyen subsp. spiciformis (Hillebr.) T.Koyama</td>
<td>ind</td>
<td>kuolohia</td>
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<tr>
<td>Cyperaceae</td>
<td><em>Rhynchospora scleroides</em> Hook. &amp; Arn.</td>
<td>ind</td>
<td>kuolohia</td>
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<td>Juncaceae</td>
<td><em>Juncus planifolius</em> R.Br.</td>
<td>nat</td>
<td>rush, bog rush</td>
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<tr>
<td>Liliaceae</td>
<td><em>Astelia menziesiana</em> Sm.</td>
<td>end</td>
<td>pa‘iniu</td>
<td></td>
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<tr>
<td>FAMILY</td>
<td>FULL NAME</td>
<td>STATUS</td>
<td>COMMON NAME</td>
<td>FED ST</td>
<td>WRA SCORE</td>
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</tr>
<tr>
<td>Liliaceae</td>
<td>Dianella sandwicensis Hook. &amp; Arn.</td>
<td>ind</td>
<td>‘ukiʻuki, ‘uki</td>
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<tr>
<td>Orchidaceae</td>
<td>Arundina graminifolia (D.Don) Hochr.</td>
<td>nat</td>
<td>bamboo orchid</td>
<td>11</td>
<td>H (HPWRA)</td>
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<tr>
<td>Orchidaceae</td>
<td>Dendrobium rhomboeum Lindl.</td>
<td>nat</td>
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<tr>
<td>Orchidaceae</td>
<td>Polystachya concreta (Jacq.) Garay &amp; Sweet</td>
<td>nat</td>
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<td></td>
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<tr>
<td>Orchidaceae</td>
<td>Spathoglottis plicata Blume</td>
<td>nat</td>
<td>Philippine ground orchid</td>
<td>16</td>
<td>H (HPWRA)</td>
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<tr>
<td>Pandanaceae</td>
<td>Freycinetia arborea Gaudich.</td>
<td>ind</td>
<td>‘ieʻie</td>
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<tr>
<td>Poaceae</td>
<td>*Andropogon virginicus L.</td>
<td>nat</td>
<td>broomsedge</td>
<td>20</td>
<td>H (Hawaiʻi)</td>
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<td>Poaceae</td>
<td>Axonopus fissifolius (Raddi) Kuhlm.</td>
<td>nat</td>
<td>narrow-leaved carpetgrass</td>
<td>16</td>
<td>H (HPWRA)</td>
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<tr>
<td>Poaceae</td>
<td>Isachne distichophylla Munro ex Hillebr.</td>
<td>end</td>
<td>‘ohe</td>
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<tr>
<td>Poaceae</td>
<td>Isachne pallens Hillebr.</td>
<td>end</td>
<td></td>
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<tr>
<td>Poaceae</td>
<td>Oplismenus hirtellus (L.) P.Beauv.</td>
<td>nat</td>
<td>basketgrass</td>
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<tr>
<td>Poaceae</td>
<td>Panicum hillebrandianum Hitchc.</td>
<td>end</td>
<td></td>
<td></td>
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<tr>
<td>Poaceae</td>
<td>Panicum koolauense H.St.John &amp; Hosaka</td>
<td>end</td>
<td></td>
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<tr>
<td>Poaceae</td>
<td>Paspalum conjugatum P.J.Bergius</td>
<td>nat</td>
<td>Hilo grass, sour paspalum</td>
<td>28</td>
<td>H (Hawaiʻi)</td>
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<tr>
<td>Poaceae</td>
<td>Paspalum scrobiculatum L.</td>
<td>ind?</td>
<td>ricegrass, mauʻu laiki</td>
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<tr>
<td>Poaceae</td>
<td>Saccoilepis indica (L.) Chase</td>
<td>nat</td>
<td>Glenwood grass</td>
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<td>Poaceae</td>
<td>Setaria parviflora (Poir.) Kerguēlen</td>
<td>nat</td>
<td>yellow foxtail</td>
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<td>Smilacaceae</td>
<td>Smilax melastomifolia Sm.</td>
<td>end</td>
<td>hoʻi kuahiwi</td>
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<td>GYMNOSPERMS</td>
<td>Cryptomeria japonica (L.f.) D.Don</td>
<td>nat</td>
<td>sugi pine</td>
<td>-3</td>
<td>L (HPWRA)</td>
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<td>PTERIDOPHYTES</td>
<td>Asplenium contiguum Kauf. var. contiguum</td>
<td>end</td>
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<tr>
<td>Athyriaceae</td>
<td>Deparia petersenii (Kunze) M.Kato</td>
<td>nat</td>
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<tr>
<td>Athyriaceae</td>
<td>Diplazium sandwichianum (C.Presl) Diels</td>
<td>end</td>
<td>hōʻiʻo</td>
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<tr>
<td>Blechnaceae</td>
<td>Blechnum appendiculatum Wild.</td>
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<tr>
<td>Blechnaceae</td>
<td>Sadleria cyatheoides Kauf.</td>
<td>end</td>
<td>‘amaʻu</td>
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<tr>
<td>Blechnaceae</td>
<td>Sadleria pallida Hook. &amp; Arn.</td>
<td>end</td>
<td>‘amaʻu ‘iʻi</td>
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<td>Blechnaceae</td>
<td>Sadleria squarrosa (Gaudich.) T.Moore</td>
<td>end</td>
<td>‘apuʻu</td>
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<tr>
<td>Dicksoniaceae</td>
<td>Cibotium glaucum (Sm.) Hook. &amp; Arn.</td>
<td>end</td>
<td>hāpuʻu, hāpuʻu pulu</td>
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<tr>
<td>Dicksoniaceae</td>
<td>Cibotium menziesii Hook.</td>
<td>end</td>
<td>hāpuʻu ‘iʻi</td>
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<tr>
<td>Elaphoglossaceae</td>
<td>Elaphoglossum alatum Gaudich.</td>
<td>end</td>
<td>hoe a Māui, ʻēkaha</td>
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<tr>
<td>FAMILY</td>
<td>FULL NAME</td>
<td>STATUS</td>
<td>COMMON NAME</td>
<td>FED ST</td>
<td>WRA SCORE</td>
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<td>Elaphoglossaceae</td>
<td>Elaphoglossum crassifolium (Gaudich.) W.R.Anderson &amp; Crosby</td>
<td>end</td>
<td>hoe a Māui, ʻēkaha</td>
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<tr>
<td></td>
<td>Elaphoglossum fauriei Copel.</td>
<td>end</td>
<td>hoe a Māui, ʻēkaha</td>
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<td>Gleicheniaceae</td>
<td>Dicranopteris linearis (Burm. f.) Underw. f. linearis</td>
<td>ind</td>
<td>uluhe</td>
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<td>Gleicheniaceae</td>
<td>Dipladotygium pinnatum (Kunze) Nakai</td>
<td>end</td>
<td>uluhe lau nui</td>
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<td>Grammitidaceae</td>
<td>Adenophorus abietinus (D.C.Eaton) K.A.Wilson</td>
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<td>Grammitidaceae</td>
<td>Adenophorus haalilioanus (Brack.) K.A.Wilson</td>
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<td>Grammitidaceae</td>
<td>Adenophorus hymenophylloides (Kaulf.) Hook. &amp; Grev.</td>
<td>end</td>
<td>pai, palai huna</td>
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<td>Grammitidaceae</td>
<td>Adenophorus pinnatifidus Gaudich. var. pinnatifidus</td>
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<td>Grammitidaceae</td>
<td>Adenophorus tamariscinus (Kaulf.) Hook. &amp; Grev. var. tamariscinus</td>
<td>end</td>
<td>wahine noho mauna</td>
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<td>end</td>
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<td>palai hinahina</td>
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<td>Hymenophyllaceae</td>
<td>Vandenboschia cyrtotheca (Hillebr.) Copel.</td>
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<td>ind</td>
<td>palaʻā</td>
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<td>Lycopodiaceae</td>
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<td>ind</td>
<td>wāwaeʻiole</td>
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<td>Maratttiaceae</td>
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<td>muleʻs-foot fern</td>
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<td>ind</td>
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<td>kupukupu</td>
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<td>lepelepe a moa</td>
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<td>palapalai a Kamaruaʻa</td>
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<td>hōʻiʻo kula</td>
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APPENDIX B: Guide to Scientific Name Changes Affecting Plant Taxa Mentioned in this Report

To the frustration of many, scientific name usage changes over time, such as when taxonomists discover new phylogenetic relationships via molecular research, or as type specimens are examined and older names with priority are discovered. This table presents scientific names used in this report that have changed since their usage in the original edition of the Manual of the Flowering Plants of Hawai‘i (Wagner et al. 1990), or subsequent to the names used in Hawai‘i’s Ferns and Fern Allies (Palmer 2003).

<table>
<thead>
<tr>
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<th>Old name</th>
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<td>Rollandia crispa</td>
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<td>Cyanea humboldtiana</td>
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<td>Cyanea lanceolata</td>
<td>Rollandia lanceolata</td>
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<td>Cyanea longiflora</td>
<td>Rollandia longiflora</td>
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<td>Cyanea st.-johnii</td>
<td>Rollandia st.-johnii</td>
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<td>Christella parasitica</td>
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<tr>
<td>Cyclosorus sandwicensis</td>
<td>Pneumatopteris sandwicensis</td>
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<td>Chamaesyce rockii</td>
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<td>Paraserianthes falcataria</td>
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<td>Kadua centranthoides</td>
<td>Hedyotis centranthoides</td>
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<td>Kadua fluviatilis</td>
<td>Hedyotis fluviatilis</td>
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<td>Kadua fosbergii</td>
<td>Hedyotis fosbergii</td>
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<td>Styphelia tameiameiae</td>
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<td>Lobelia gaudichaudii subsp. koolaulensis</td>
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<td>Pelea hiakae</td>
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<td>Melicope hosakae</td>
<td>Pelea honolulensis</td>
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<td>Pelea lydgatei</td>
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<td>Pluchea symphytifolia</td>
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<td>Stachytarpheta dichotoma</td>
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<td>Thelypteris globulifera</td>
<td>Amauropelta globulifera</td>
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APPENDIX C: Historical Vouchers of Rare and Endangered Plant Taxa Located at Bishop Museum

The Herbarium Pacificum at Bishop Museum houses over 750,000 preserved plant specimens from around the world, but primarily concentrated in the Hawaiian Islands and Pacific Basin. The Hawaiian vascular plant collection itself numbers about 140,000 specimens, and data entry into a relational database has been completed for all attached label information, thus allowing for queries of geographical distribution based on place name localities provided by the collector. Such a query, based on the keywords Kipapa, Waikakalaua, and Waiawa on O‘ahu, produced over 1,600 collections from throughout the length of each stream drainage. The list was then distilled to include only those collections from upland drainages representing rare and endangered taxa, namely, those recognized by the U.S. Fish and Wildlife Service as Endangered, Candidate, or Species of Concern (USFWS 2010a), and is reproduced below for historical background.

<table>
<thead>
<tr>
<th>Family</th>
<th>Scientific name</th>
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<th>Collector</th>
<th>Coll date</th>
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<td>Sanicula purpurea H.St.John &amp; Hosaka</td>
<td>Kipapa Gulch, on exposed mossy, turfy ridge; bad odor</td>
<td>860m</td>
<td>Fosberg</td>
<td>6.viii.1933</td>
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<tr>
<td>Apiaceae</td>
<td>Sanicula purpurea H.St.John &amp; Hosaka</td>
<td>Kipapa–Waiähole crest, Metrodiersos-Chirotodendron forest</td>
<td>850m</td>
<td>Grant</td>
<td>7.viii.1934</td>
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<tr>
<td>Apiaceae</td>
<td>Sanicula purpurea H.St.John &amp; Hosaka</td>
<td>Kipapa Gulch, on wet windswept main divide of range</td>
<td></td>
<td>Hosaka</td>
<td>6.viii.1933</td>
</tr>
<tr>
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<td>Sanicula purpurea H.St.John &amp; Hosaka</td>
<td>Ridge S of Kipapa Gulch; rain forest</td>
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<td>Morley</td>
<td>10.xii.1933</td>
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<td>Araliaceae</td>
<td>Polyscias gymnocarpa (Hillebr.) Lowry &amp; G.M.Plunkett</td>
<td>Kipapa–Waiaawa Ridge; Metrodiersos forest; 15ft tree</td>
<td>792m</td>
<td>Grant</td>
<td>7.viii.1934</td>
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<td>Araliaceae</td>
<td>Polyscias gymnocarpa (Hillebr.) Lowry &amp; G.M.Plunkett</td>
<td>Waikakalaua Gulch, along wooded streambed; 35ft tree</td>
<td>305m</td>
<td>Hosaka</td>
<td>14.ix.1930</td>
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<tr>
<td>Araliaceae</td>
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<td>Hosaka</td>
<td>18.ix.1932</td>
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<td>762m</td>
<td>Morley</td>
<td>10.xii.1933</td>
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<td>Kipapa Trail between 4 and 4.5 mileposts; in forest</td>
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<td>Degener et al.</td>
<td>2.vi.1935</td>
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<td>Kipapa Trail</td>
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<td>Degener et al.</td>
<td>2.vi.1935</td>
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<td>Kipapa Gulch; tree 15ft tall</td>
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<td>Grant</td>
<td>8.viii.1934</td>
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<td>Family</td>
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<td>Collector</td>
<td>Coll date</td>
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<td>Hosaka</td>
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<td></td>
<td>A.Gray</td>
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<td></td>
<td>A.Gray</td>
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<td>Kïpapa Gulch</td>
<td>520m</td>
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<td>Kïpapa Gulch; erect, unbranched undershrub 6ft high</td>
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<td>Bryan Jr</td>
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<td>Waiakakalaua Gulch</td>
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<td>Kïpapa Gulch, S ridge; moist woods</td>
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<td>29.v.1932</td>
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<td>Kïpapa Gulch, S ridge; wet woods</td>
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<td>2.vii.1933</td>
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<td>6.viii.1933</td>
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<td>7.viii.1933</td>
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<td>Lammers, Givnish &amp; Sytsma</td>
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<td>Campanulaceae</td>
<td>Cyanea crispa (Gaudich.) Lammers</td>
<td>Kïpapa Gulch, S ridge; in moderately moist gully</td>
<td>275m</td>
<td>Hosaka</td>
<td>20.v.1932</td>
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<td>Lammers, Givnish &amp; Sytsma</td>
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<td>Campanulaceae</td>
<td>Cyanea crispa (Gaudich.) Lammers</td>
<td>Kïpapa Gulch, in lower forest</td>
<td>305m</td>
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<td>Campanulaceae</td>
<td>Cyanea crispa (Gaudich.) Lammers</td>
<td>Kïpapa Gulch; in moist gully</td>
<td>520m</td>
<td>Hosaka</td>
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<td>Campanulaceae</td>
<td>Cyanea crispa (Gaudich.)</td>
<td>E. of Pu’u Kamana; S ridge of Kipapa Gulch, moist gulch</td>
<td>488m</td>
<td>St. John s.n.</td>
<td>15.v.1932</td>
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<td>Campanulaceae</td>
<td>Cyanea crispa (Gaudich.)</td>
<td>Waikakalaua Gulch; flowers reddish purple, one plant 3 m tall</td>
<td>245m</td>
<td>St. John 10469</td>
<td>6.iv.1930</td>
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<td>Campanulaceae</td>
<td>Cyanea grimesiana Gaudich. grimesiana</td>
<td>Kipapa Gulch, in <em>Acacia</em> forest</td>
<td>366m</td>
<td>Grant 7275</td>
<td>8.viii.1934</td>
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<td>Cyanea grimesiana Gaudich. grimesiana</td>
<td>Kipapa Gulch, along streambed, second N fork</td>
<td>335m</td>
<td>Hosaka 830</td>
<td>13.xi.1932</td>
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<td>Campanulaceae</td>
<td>Cyanea humboldtiana (Gaudich.)</td>
<td>Kipapa; near streambed; shrub</td>
<td>425m</td>
<td>Hum 87</td>
<td>15.ii.1931</td>
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<td>Campanulaceae</td>
<td>Cyanea humboldtiana (Gaudich.)</td>
<td>Kipapa Gulch, S ridge, moderately moist gully</td>
<td>305m</td>
<td>Hosaka 516</td>
<td>15.v.1932</td>
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<td>Campanulaceae</td>
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<td>Kipapa Gulch, second N fork; along moist streambed</td>
<td>305m</td>
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<td>Cyanea humboldtiana (Gaudich.)</td>
<td>Kipapa Gulch, S ridge, moderately moist gully</td>
<td>305m</td>
<td>Hosaka 1043</td>
<td>15.v.1932</td>
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<td>Campanulaceae</td>
<td>Cyanea humboldtiana (Gaudich.)</td>
<td>Waiawa–Waipi’o ridge; rain forest</td>
<td>500m</td>
<td>Macdaniels 13</td>
<td>6.x.1926</td>
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<td>Campanulaceae</td>
<td>Cyanea koolauensis</td>
<td>S ridge of Kipapa Gulch, 2–3 ft off trail, in thicket</td>
<td>518m</td>
<td>Chang s.n.</td>
<td>15.v.1932</td>
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<td>Campanulaceae</td>
<td>Cyanea koolauensis</td>
<td>Kipapa Gulch trail</td>
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<td>Cowan 712</td>
<td>5.x.1947</td>
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<td>Campanulaceae</td>
<td>Cyanea koolauensis</td>
<td>Kipapa–Waiau Ridge, in <em>Metrosideros-Acacia</em> forest</td>
<td>549m</td>
<td>Grant 7185</td>
<td>7.viii.1934</td>
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<td>Campanulaceae</td>
<td>Cyanea koolauensis</td>
<td>Kipapa-Waiau Ridge, in <em>Metrosideros</em> forest</td>
<td>610m</td>
<td>Grant 7283</td>
<td>7.viii.1934</td>
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<td>Campanulaceae</td>
<td>Cyanea koolauensis</td>
<td>Kipapa Gulch, S ridge, on wooded ridge</td>
<td>518m</td>
<td>Hosaka 596</td>
<td>4.vii.1932</td>
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<td>Campanulaceae</td>
<td>Cyanea lanceolata (Gaudich.)</td>
<td>Kipapa Gulch, SE ridge; <em>Metrosideros-Acacia</em> forest</td>
<td>374m</td>
<td>Grant 7078</td>
<td>13.vii.1934</td>
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<td>Lammers, Givnish &amp; Sytsma</td>
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<td>Campanulaceae</td>
<td>Cyanea lanceolata</td>
<td>Kipapa Gulch, 2nd N fork</td>
<td>335m</td>
<td>Hosaka 1027</td>
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<td>Campanulaceae</td>
<td>Cyanea longiflora (Wawra) Lammers, Givnish &amp; Sytsma</td>
<td>SE ridge, Kipapa Gulch, growing in <em>Metrosideros-Acacia</em> forest</td>
<td>372m</td>
<td>Grant 7087</td>
<td>13.vii.1934</td>
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<td>Campanulaceae</td>
<td>Cyanea longiflora (Wawra) Lammers, Givnish &amp; Sytsma</td>
<td>Western division of main ridge, from Waipi’o to Helemano</td>
<td></td>
<td>Hillebrand</td>
<td>s.n.</td>
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<td>Campanulaceae</td>
<td>Cyanea longiflora (Wawra) Lammers, Givnish &amp; Sytsma</td>
<td>Kipapa Gulch, S ridge, moderately moist gully</td>
<td>305m</td>
<td>Hosaka 516</td>
<td>15.v.1932</td>
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<tr>
<td>Campanulaceae</td>
<td>Cyanea longiflora (Wawra) Lammers, Givnish &amp; Sytsma</td>
<td>Kipapa Gulch, S ridge, in moist woods</td>
<td>366m</td>
<td>Hosaka 918</td>
<td>5.iii.1933</td>
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<td>Campanulaceae</td>
<td>Cyanea longiflora (Wawra) Lammers, Givnish &amp; Sytsma</td>
<td>Waipi’o</td>
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<td>Lydgate s.n.</td>
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<td>Campanulaceae</td>
<td>Cyanea st.-johnii (Hosaka) Lammers, Givnish &amp; Sytsma</td>
<td>Ko’olau summit, above Kipapa Gulch</td>
<td>900m</td>
<td>Fosberg &amp; Hosaka 8715</td>
<td>18.ix.1932</td>
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<td>Campanulaceae</td>
<td>Cyanea st.-johnii (Hosaka) Lammers, Givnish &amp; Sytsma</td>
<td>Kipapa-Waïåhole crest, in <em>Metrosideros-Cheirodendron</em> forest</td>
<td>855m</td>
<td>Grant 7265</td>
<td>7.viii.1934</td>
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<td>Campanulaceae</td>
<td>Cyanea st.-johnii (Hosaka) Lammers, Givnish &amp; Sytsma</td>
<td>Kipapa Gulch</td>
<td>853m</td>
<td>Hosaka 743</td>
<td>18.ix.1932</td>
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<td>Campanulaceae</td>
<td>Cyanea st.-johnii (Hosaka) Lammers, Givnish &amp; Sytsma</td>
<td>Kipapa Gulch</td>
<td>853m</td>
<td>Hosaka 1159</td>
<td>6.viii.1933</td>
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<td>Campanulaceae</td>
<td>Cyanea st.-johnii (Hosaka) Lammers, Givnish &amp; Sytsma</td>
<td>Kipapa Gulch main divide</td>
<td>853m</td>
<td>Hosaka 1256</td>
<td>7.viii.1934</td>
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<tr>
<td>Campanulaceae</td>
<td>Lobelia gaudichaudii A.DC.</td>
<td>Kipapa–Waïåhole crest, <em>Metrosideros-Cheirodendron</em> forest; ascending 3 ft</td>
<td></td>
<td>Grant 7217</td>
<td>7.viii.1934</td>
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<tr>
<td>Campanulaceae</td>
<td>Lobelia gaudichaudii A.DC.</td>
<td>Kipapa Gulch, main divide</td>
<td>853m</td>
<td>Hosaka 686</td>
<td>18.ix.1932</td>
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<tr>
<td>Campanulaceae</td>
<td>Lobelia gaudichaudii A.DC.</td>
<td>Kipapa trail right of Kipapa Gulch, lower cloud zone, 200 yds from top</td>
<td>823m</td>
<td>Ozaki 561</td>
<td>27.ix.1953</td>
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<tr>
<td>Campanulaceae</td>
<td>Lobelia gaudichaudii A.DC.</td>
<td>Kipapa Gulch, Waipi’o-Waïåhole divide, S ridge; flowers claret</td>
<td>853m</td>
<td>St. John 12077</td>
<td>18.ix.1932</td>
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<td>Campanulaceae</td>
<td>Lobelia gaudichaudii A.DC.</td>
<td>1st peak S of Pu’u Ka’aumakua, windswept in cloud zone</td>
<td>808m</td>
<td>St. John 20252</td>
<td>14.ix.1941</td>
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<td>Campanulaceae</td>
<td>Lobelia hypoleuca Hillebr.</td>
<td>Kipapa Gulch, S ridge, at head of valley in streambed</td>
<td>549m</td>
<td>Hosaka 797</td>
<td>16.x.1932</td>
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<td>Campanulaceae</td>
<td>Lobelia oahuensis Rock</td>
<td>Kipapa Gulch, main divide, on wet open slope; upright plant, 10ft high</td>
<td>853m</td>
<td>Hosaka 685</td>
<td>18.ix.1932</td>
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<td>Campanulaceae</td>
<td>Lobelia oahuensis Rock</td>
<td>Kipapa Gulch, main divide, on wet open slope; upright plant, 8ft high</td>
<td></td>
<td>Hosaka 1156</td>
<td>6.viii.1933</td>
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<td>Euphorbiaceae</td>
<td>Euphorbia rockii</td>
<td>Waiawa</td>
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<td>Russ s.n.</td>
<td>ii.1930</td>
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<td>C.N.Forbes.</td>
<td>Waiawa, Waikāne Trail</td>
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<td>Topping</td>
<td>27.xii.1925</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch, 2nd branch</td>
<td>305m</td>
<td>Hosaka</td>
<td>16.ii.1930</td>
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<td></td>
<td>Wawra</td>
<td>Kīpapa Gulch, S Ridge</td>
<td>518m</td>
<td>Hosaka</td>
<td>4.ii.1992</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch, N Ridge, in moist streambed</td>
<td>366m</td>
<td>Hosaka</td>
<td>10.ii.1932</td>
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<tr>
<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch, S Ridge; near streambed</td>
<td>518m</td>
<td>Hosaka</td>
<td>18.ii.1932</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch, 2nd N fork</td>
<td>518m</td>
<td>Hosaka</td>
<td>13.ii.1932</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch; moist gully</td>
<td>549m</td>
<td>Hosaka</td>
<td>6.ii.1933</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch, S ridge; on wet ridge</td>
<td>640m</td>
<td>Hosaka</td>
<td>6.iii.1933</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch; by stream</td>
<td>610m</td>
<td>St. John</td>
<td>12.075</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>N Fork of Kīpapa Gulch, in dark ravine</td>
<td>366m</td>
<td>Storey</td>
<td>13.ii.1932</td>
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<tr>
<td>Gesneriaceae</td>
<td>Cyrtandra kalihii Wawra</td>
<td>Kīpapa Gulch, in small, densely shaded, humid ravine, leading into main stream</td>
<td>457m</td>
<td>Storey</td>
<td>11.ii.1935</td>
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<td>Gesneriaceae</td>
<td>Cyrtandra viridiflora H.St.John &amp; Storey</td>
<td>Waikāne-Waipi’o, 1st peak S of Pu’u Ka’umakua, low moist turf, wind-swept windward crest; 5 dm shrub</td>
<td>762m</td>
<td>St. John</td>
<td>7.ii.1939</td>
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<td>Lamiaeae</td>
<td>Phyllostegia hirsuta Benth.</td>
<td>Kīpapa Trail 1 mile from summit; sprawling; 3ft high</td>
<td></td>
<td>Degener et al. 9977</td>
<td>2.ii.1935</td>
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<td>Lamiaeae</td>
<td>Phyllostegia hirsuta Benth.</td>
<td>Waikakalaua Gulch</td>
<td>305m</td>
<td>Hosaka</td>
<td>6.ii.1930</td>
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<tr>
<td>Lamiaeae</td>
<td>Phyllostegia hirsuta Benth.</td>
<td>Kīpapa Gulch, 3ft shrub</td>
<td>518m</td>
<td>Hosaka</td>
<td>6.ii.1933</td>
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<tr>
<td>Lamiaeae</td>
<td>Phyllostegia hirsuta Benth.</td>
<td>Waikakalaua Gulch, near Waikakalaua-Kīpapa divide</td>
<td>457m</td>
<td>Nitta</td>
<td>6.ii.1930</td>
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<tr>
<td>Lamiaeae</td>
<td>Phyllostegia parviflora (Gaudich.) Benth.</td>
<td>Kīpapa Gulch, 2nd N fork</td>
<td></td>
<td>Hosaka</td>
<td>11.ii.1933</td>
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<td>Lauraceae</td>
<td>Cryptocarya mannii Hillebr.</td>
<td>Kīpapa gulch, lower forest; tree 20ft high</td>
<td>366m</td>
<td>Hosaka</td>
<td>30.ii.1933</td>
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<tr>
<td>Loganiaceae</td>
<td>Labordia cyrtandrae (Baill.) H.St.John</td>
<td>Kīpapa trail to Ko’olau summit, N-facing slope; in wet forest gully</td>
<td>518m</td>
<td>Degener et al. 10000</td>
<td>2.ii.1935</td>
</tr>
<tr>
<td>Loganiaceae</td>
<td>Labordia cyrtandrae (Baill.) H.St.John</td>
<td>Kīpapa Gulch; wet forest; bush 1.5 m tall</td>
<td>450m</td>
<td>Fosberg</td>
<td>12.ii.1933</td>
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<td>Loganiaceae</td>
<td>Labordia cyrtandrae (Baill.) H.St.John</td>
<td>Waikakalaua Gulch; in moist gully</td>
<td>457m</td>
<td>Hosaka</td>
<td>6.ii.1930</td>
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<tr>
<td>Loganiaceae</td>
<td>Labordia cyrtandrae (Baill.) H.St.John</td>
<td>S ridge, Kīpapa Gulch</td>
<td>457m</td>
<td>Hosaka</td>
<td>4.ii.1932</td>
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<td>Loganiaceae</td>
<td>Labordia cyrtandrae (Baill.) H.St.John</td>
<td>Kīpapa Gulch; in wet gully; 4ft shrub</td>
<td>518m</td>
<td>Hosaka</td>
<td>6.ii.1933</td>
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<td>Loganiaceae</td>
<td>Labordia cyrtandrae (Baill.) H.St.John</td>
<td>Kīpapa Gulch, 2nd N fork; in moist gully; 5ft shrub</td>
<td>457m</td>
<td>Hosaka</td>
<td>11.ii.1933</td>
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<td>Loganiaceae</td>
<td>Labordia cyrtandrae (Baill.) H.St.John</td>
<td>Kīpapa Gulch, S ridge; in wet gully;</td>
<td>457m</td>
<td>Hosaka</td>
<td>4.ii.1932</td>
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<td>Family</td>
<td>Scientific name</td>
<td>Locality/Habitat/Plt description</td>
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<td>Collector</td>
<td>Coll date</td>
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<tr>
<td>Loganiaceae</td>
<td>Labordia hosakana (Sherff) W.L. Wagner, D.R.Herbst &amp; Sohmer</td>
<td>Kipapa Trail summit</td>
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<td>Degener et al. 10152a</td>
<td>2.vi.1935</td>
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<td>Labordia hosakana (Sherff) W.L. Wagner, D.R.Herbst &amp; Sohmer</td>
<td>Kipapa Gulch; exposed ridge</td>
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<td>Fosberg 9729</td>
<td>6.viii.1933</td>
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<td>Kipapa-Waiałhole crest; Metrosideros-Cheirodendron forest</td>
<td>853m</td>
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<td>Labordia hosakana (Sherff) W.L. Wagner, D.R.Herbst &amp; Sohmer</td>
<td>Kipapa Gulch, S ridge; denuded ridge; shrub 4ft high</td>
<td>762m</td>
<td>Hosaka 679</td>
<td>4.vi.1932</td>
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<td>Ridge S of Kipapa Gulch; rain forest</td>
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<td>Morley 71</td>
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<td>Gardenia mannii H.St.John &amp; Kuykendall</td>
<td>Waipi’o-Waiawa Ridge</td>
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<td>Gardenia mannii H.St.John &amp; Kuykendall</td>
<td>Kipapa Valley trail, SE edge of valley; in lower rain forest, bottom of gully; tree 40ft high</td>
<td>335m</td>
<td>Kuykendall 116</td>
<td>30.ix.1945</td>
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<td>Kadua fluviatilis C.N.Forbes</td>
<td>Kipapa Gulch</td>
<td>305m</td>
<td>Hosaka 150</td>
<td>16.i.1930</td>
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<td>Kipapa Gulch, near stream</td>
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<td>Hume 85</td>
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<td>Kipapa Gulch</td>
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<td>2nd N fork, Kipapa Gulch; flowers white</td>
<td>427m</td>
<td>St. John 11023</td>
<td>15.xi.1931</td>
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<td>N Fork, Kipapa Gulch</td>
<td>335–427m</td>
<td>Storey 115</td>
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<td>Morinda trimera Hillebr.</td>
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<td>Hosaka 963</td>
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<td>2nd N fork, Kipapa Gulch, wet forest; 8 m tree</td>
<td>450m</td>
<td>Fosberg et al. 9567</td>
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<td>Kipapa Gulch; wet forest, bottom of gulch</td>
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<td>Fosberg</td>
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<td>Kipapa Gulch, streambed; 35ft tall tree</td>
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<td>Kipapa Gulch; 10ft tall tree; odd fruit</td>
<td>457m</td>
<td>Grant</td>
<td>8.viii.1934</td>
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<td>Kipapa Gulch, S ridge; on wooded ridge</td>
<td>549m</td>
<td>Hosaka</td>
<td>16.x.1932</td>
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<td>Rutaceae</td>
<td>Melicope lydgatei (Hillebr.) T.G.Hartley &amp; B.C.Stone</td>
<td>Kipapa Gulch, N ridge; wooded slope</td>
<td>396m</td>
<td>Hosaka</td>
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<td>Rutaceae</td>
<td>Melicope lydgatei (Hillebr.) T.G.Hartley &amp; B.C.Stone</td>
<td>Kipapa Gulch, S ridge; on moist wooded ridge</td>
<td>549m</td>
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<td>503m</td>
<td>St. John</td>
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<td>Melicope lydgatei (Hillebr.) T.G.Hartley &amp; B.C.Stone</td>
<td>S ridge of Kipapa Gulch, E of Pu‘u Kamana; wooded slope; 10ft prostrate shrub</td>
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<td>St. John</td>
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<td>Melicope lydgatei (Hillebr.) T.G.Hartley &amp; B.C.Stone</td>
<td>S ridge of Kipapa Gulch, on ridge in woods; 15ft fastigate shrub</td>
<td>457m</td>
<td>St. John</td>
<td>12083</td>
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<td>Kipapa Gulch, 2nd N fork</td>
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<td>Rutaceae</td>
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<td>Kipapa Gulch, S ridge; 4ft tall shrub</td>
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<td>Hosaka</td>
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<td>Kipapa trail, ridge ~1 mi. from summit, rainy</td>
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<td>Kipapa-Waiawa Ridge. <em>Metrosideros</em> forest; 15ft tree</td>
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<td>Kipapa Gulch, S ridge, denuded; 10ft tall tree</td>
<td>610m</td>
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<td>Zanthoxylum oahuense Hillebr.</td>
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<td>Kipapa Gulch, S ridge; in low, moist forest; young tree 4m tall</td>
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<td>St. John</td>
<td>13.iv.1947</td>
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<td>Waipi‘o-Waiawa ridge</td>
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<td>Swezey s.n.</td>
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<td>Coll date</td>
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<td>Santalaceae</td>
<td>Exocarpos gaudichaudii A.DC.</td>
<td>S ridge of Kïpapa Gulch</td>
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<td>Chang s.n.</td>
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<td>Waipi’o-Waiawa ridge</td>
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<td>Kïpapa Gulch</td>
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<td>Kïpapa Gulch</td>
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<td>Kïpapa Gulch, S ridge; 20ft tree</td>
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<td>Ridge S of Kïpapa Gulch; much-branching plant</td>
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<td>Kïpapa Trail, ~1.25 mi. from boundary, ridgeline N and perpendicular to trail</td>
<td>477m</td>
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<td>Kïpapa-Waiawa Ridge spur that runs into Waiawa Valley</td>
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<td>Waipi‘o-Waiawa Ridge, S ridge of Kïpapa Gulch; moist forest; bushy tree 5 m tall</td>
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<td>Fosberg &amp; Hosaka 13908</td>
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<td>Violaceae</td>
<td>Viola oahuensis C.N.Forbes</td>
<td>Kïpapa Gulch, exposed, turfy ridge</td>
<td>860m</td>
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<td>Kïpapa Gulch, exposed, wet place</td>
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<td>Waipi‘o–Kïpapa Gulch, S ridge; rain forest; upright shrub</td>
<td>792m</td>
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**MONOCOTS**
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<th>Elev</th>
<th>Collector</th>
<th>Coll date</th>
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<td>Joinvillea ascendens</td>
<td>Kipapa Gulch; canes 2–3 m tall</td>
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<td>Fosberg</td>
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<td>549–610m</td>
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<td>S ridge, Kipapa Gulch, on wooded ridge</td>
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<td>Hosaka</td>
<td>2.vii.1933</td>
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<td>Summit trail between Kipapa Trail and Pu’u Ka’aumakua to the north.</td>
<td>838m</td>
<td>Imada</td>
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<td>Anoectochilus sandvicensis Lindl.</td>
<td>Kipapa-Waiawa Ridge, Metrosideros forest</td>
<td>579m</td>
<td>Grant</td>
<td>7.viii.1934</td>
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<td>7246</td>
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<td>Orchidaceae</td>
<td>Anoectochilus sandvicensis Lindl.</td>
<td>Kipapa Gulch, S ridge; mossy tree trunk</td>
<td>610m</td>
<td>Hosaka</td>
<td>12.xi.1933</td>
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<td>1230</td>
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<tr>
<td>Orchidaceae</td>
<td>Liparis hawaiensis H.Mann</td>
<td>S Kipapa Gulch; ridge, rainforest, on bark of tree</td>
<td>610m</td>
<td>Fosberg</td>
<td>18.ix.1932</td>
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<td>Orchidaceae</td>
<td>Liparis hawaiensis H.Mann</td>
<td>Kipapa Gulch, Metrosideros, Antidesma</td>
<td>518m</td>
<td>Grant</td>
<td>7.viii.1934</td>
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<tr>
<td>Orchidaceae</td>
<td>Liparis hawaiensis H.Mann</td>
<td>Waikakalaua Gulch; mossy tree branch 15ft in air</td>
<td>396m</td>
<td>Hosaka</td>
<td>14.x.1930</td>
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<td>Orchidaceae</td>
<td>Liparis hawaiensis H.Mann</td>
<td>Between head of Kipapa and Uwau gulches; mossy trunk</td>
<td>792m</td>
<td>Hosaka &amp;</td>
<td>30.v.1937</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Fosberg</td>
<td></td>
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<td>1872</td>
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<td>Orchidaceae</td>
<td>Liparis hawaiensis H.Mann</td>
<td>S ridge, Kipapa Gulch; mossy trunk</td>
<td>457m</td>
<td>St. John</td>
<td>4.vii.1932</td>
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<td>10570</td>
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<td>Orchidaceae</td>
<td>Platanthera holochila</td>
<td>Head of Kipapa Gulch</td>
<td></td>
<td>Selling</td>
<td>3.vii.1938</td>
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<td></td>
<td>(Hillebr.) Kraenzl.</td>
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<td>2622</td>
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<tr>
<td>Poaceae</td>
<td>Panicum koolauense H.St.John &amp; Hosaka</td>
<td>Back of Kipapa, near summit</td>
<td>762m</td>
<td>Beardsley</td>
<td>17.iv.1958</td>
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<td>s.n.</td>
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<tr>
<td>Poaceae</td>
<td>Panicum koolauense H.St.John &amp; Hosaka</td>
<td>Kipapa Trail to summit ridge, on wind- and cloud-swept summit; forming tussocks</td>
<td>762m</td>
<td>Degener et al. 9997</td>
<td>2.vi.1935</td>
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<tr>
<td>Poaceae</td>
<td>Panicum koolauense H.St.John &amp; Hosaka</td>
<td>Ko‘olau summit above Kipapa Gulch, Waiāhole; windward-facing ledges; in tufts and mats betw. rocks</td>
<td>900m</td>
<td>Fosberg</td>
<td>18.ix.1932</td>
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<td>8671</td>
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<td>Poaceae</td>
<td>Panicum koolauense H.St.John &amp; Hosaka</td>
<td>Kipapa Gulch, on wet exposed ridge; dense turf</td>
<td>860m</td>
<td>Fosberg</td>
<td>8.vi.1933</td>
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<td>Coll date</td>
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<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Kipapa-Waiahole crest, <em>Metrosideros-Antidesma</em> forest</td>
<td>853m</td>
<td>Grant 7219</td>
<td>7.viii.1934</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Main divide, Kipapa Gulch, on wet windswept ridge</td>
<td>853m</td>
<td>Hosaka 630</td>
<td>4.vii.1932</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Main divide, Kipapa Gulch, on wet denuded ridge; forming mat</td>
<td>853m</td>
<td>Hosaka 709</td>
<td>18.ix.1932</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Main divide, Kipapa Gulch, forming mat</td>
<td>853m</td>
<td>Hosaka 1154</td>
<td>6.viii.1933</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Kipapa-Waiahole summit</td>
<td></td>
<td>Kerr s.n.</td>
<td>4.vii.1946</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Kipapa Gulch, ridge on right-hand side; forming one large cushion</td>
<td>366–610m</td>
<td>Kondo s.n.</td>
<td>14.iv.1946</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Ridge S of Kipapa Gulch</td>
<td>792m</td>
<td>Morley 56</td>
<td>10.xii.1933</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>On top of ridge at junction of ridge S of Kipapa Gulch with the main Ko‘olau Ridge; wet forest</td>
<td>853m</td>
<td>Morley 190</td>
<td>10.i.1935</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Ridge S of Kipapa Gulch, densely tufted, 2–3in high</td>
<td>792m</td>
<td>Morley s.n.</td>
<td>10.xii.1933</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Panicum koolauense</td>
<td>Kipapa Trail, S ridge of Kipapa Gulch, in tufts on ground</td>
<td>792m</td>
<td>Ozaki 564</td>
<td>27.ix.1953</td>
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<tr>
<td>PTERIDOPHYTES</td>
<td>Blechnaceae</td>
<td>Doodia lyonii O.Deg. Kipapa Gulch; shady bank above stream</td>
<td>550m</td>
<td>Fosberg 9797</td>
<td>8.viii.1933</td>
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<td></td>
<td>Blechnaceae</td>
<td>Doodia lyonii O.Deg. Kipapa Gulch, streambed</td>
<td>460m</td>
<td>Hosaka 803</td>
<td>16.x.1932</td>
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<tr>
<td></td>
<td>Blechnaceae</td>
<td>Doodia lyonii O.Deg. Kipapa Stream; damp gorge</td>
<td>305m</td>
<td>St. John 10012</td>
<td>10.xi.1929</td>
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<tr>
<td></td>
<td>Blechnaceae</td>
<td>Doodia lyonii O.Deg. Kipapa; Waikakalaua Gulch; steep damp slope</td>
<td>425m</td>
<td>Topping sub Degener 5895</td>
<td>6.iv.1930</td>
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</tbody>
</table>
APPENDIX D: Historical Vouchers of Non-native Plants Located at Bishop Museum

Using the same methodology that created the rare plant voucher list in Appendix C, this table collects all of the historic non-native vouchers in the Herbarium Pacificum at Bishop Museum from the upper portions of the Kipapa, Waikakalaua, and Waiawa stream drainages.

<table>
<thead>
<tr>
<th>Family</th>
<th>Scientific name</th>
<th>Locality/Habitat/Plt description</th>
<th>Elev</th>
<th>Collector</th>
<th>Coll date</th>
</tr>
</thead>
<tbody>
<tr>
<td>DICOTS</td>
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<tr>
<td>Anacardiaceae</td>
<td>Anacardium occidentale L.</td>
<td>Kipapa Gulch; small trees at edge of forest</td>
<td></td>
<td>Bryan s.n.</td>
<td>27.iv.1941</td>
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<tr>
<td>Anacardiaceae</td>
<td>Anacardium occidentale L.</td>
<td>Kipapa Gulch</td>
<td></td>
<td>Cowan</td>
<td>29.ix.1946</td>
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<tr>
<td>Anacardiaceae</td>
<td>Anacardium occidentale L.</td>
<td>S ridge of Kipapa Gulch; dry forest</td>
<td>381m</td>
<td>Shinohara</td>
<td>9.ix.1946</td>
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<tr>
<td>Apiaceae</td>
<td>Centella asiatica (L.) Urb.</td>
<td>Kipapa Trail, ~100m from refuge boundary, along edges of trail; wet lowland</td>
<td>457m</td>
<td>Reynolds et al. 72b</td>
<td>31.v.2006</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>Hydrocotyle verticillata Thunb.</td>
<td>S ridge of Kipapa Gulch</td>
<td>366–427m</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>Hydrocotyle verticillata Thunb.</td>
<td>Kipapa Gulch, muddy gulch floor</td>
<td>500m</td>
<td>Fosberg 9803</td>
<td>8.viii.1933</td>
</tr>
<tr>
<td>Araliaceae</td>
<td>Schefflera actinophylla (Endl.) Harms</td>
<td>Kipapa Trail, ~2/3mi from refuge boundary, S side of trail, upslope; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>480m</td>
<td>Reynolds 107b</td>
<td>6.vii.2006</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Ageratina riparia (Regel) R.M.King &amp; H.Rob.</td>
<td>Kipapa Trail, 0.75mi from refuge boundary, off-trail, ridgeline N and perpendicular to trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>494m</td>
<td>Reynolds &amp; Lynch 200</td>
<td>6.vii.2006</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Crassocephalum crepidioides (Benth.) S.Moore</td>
<td>Kipapa Trail, ~1/2mi from refuge boundary, S side of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>475m</td>
<td>Reynolds &amp; Hoffmann 105b</td>
<td>1.vi.2006</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Emilia fosbergii Nicolson</td>
<td>Kipapa Gulch, 2nd N fork</td>
<td>381m</td>
<td>Inafuku s.n.</td>
<td>15.ii.1931</td>
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<tr>
<td>Asteraceae</td>
<td>Emilia sonchifolia (L.) DC. var. javanica (Burm.f.) Mattf.</td>
<td>Kipapa Trail, 1.5mi from refuge boundary, N side of trail, S side of hunter trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>533m</td>
<td>Reynolds 187</td>
<td>29.vi.2006</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Erechites valerianifolia (Wolf) DC.</td>
<td>Kipapa Trail, ~3/4mi from refuge boundary, N side of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~75cm herb</td>
<td>494m</td>
<td>Reynolds &amp; Hoffmann 136</td>
<td>13.vi.2006</td>
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<tr>
<td>Asteraceae</td>
<td>Erechites valerianifolia (Wolf) DC.</td>
<td>S ridge of Kipapa Gulch</td>
<td></td>
<td>Wilbur 244</td>
<td>5.x.1947</td>
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<td>Family</td>
<td>Scientific name</td>
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<td>Collector</td>
<td>Coll date</td>
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<tr>
<td>Asteraceae</td>
<td>Pluchea carolinensis (Jacq.) G.Don</td>
<td>Kipapa Trail, off trail, S of trail, third drainage E of Pu‘u Kamana, W bank; wet lowland forest; <em>Metrosideros, Acacia, Dicranopteris, Psidium cattleianum</em>; ~2m shrub</td>
<td>407m</td>
<td>Reynolds &amp; Suzuki 130a</td>
<td>10.vi.2006</td>
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<tr>
<td>Asteraceae</td>
<td>Youngia japonica (L.) DC.</td>
<td>S ridge of Kipapa Gulch</td>
<td>366–427m</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
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<td>Asteraceae</td>
<td>Youngia japonica (L.) DC.</td>
<td>Kipapa-Waiawa Ridge</td>
<td>2200ft</td>
<td>Grant 7201</td>
<td>7.viii.1934</td>
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<td>Asteraceae</td>
<td>Youngia japonica (L.) DC.</td>
<td>S ridge Kipapa Gulch</td>
<td>335m</td>
<td>St. John 10025</td>
<td>10.xi.1929</td>
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<td>Buddlejaceae</td>
<td>Buddleja asiatica Lour.</td>
<td>Kipapa-Waiawa Ridge; <em>Metrosideros</em> forest; 5f shrub</td>
<td>1900ft</td>
<td>Grant 7247</td>
<td>7.viii.1934</td>
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<tr>
<td>Buddlejaceae</td>
<td>Buddleja asiatica Lour.</td>
<td>Kipapa gulch; streambed</td>
<td>1500ft</td>
<td>Hosaka 785</td>
<td>16.x.1932</td>
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<tr>
<td>Buddlejaceae</td>
<td>Buddleja asiatica Lour.</td>
<td>Kipapa Gulch; wet region, near river side</td>
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<td>Koike s.n.</td>
<td>15.ii.1931</td>
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<td>Cannabaceae</td>
<td>Cannabis sativa L.</td>
<td>Kipapa Gulch</td>
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<td>Honolulu Police Dept. s.n.</td>
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<td>Convolvulaceae</td>
<td>Ipomoea alba L.</td>
<td>Kipapa-Waiawa ridge; creek bed</td>
<td>1350ft</td>
<td>Grant 7284</td>
<td>8.viii.1934</td>
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<tr>
<td>Convolvulaceae</td>
<td>Ipomoea alba L.</td>
<td>S ridge of Kipapa Gulch, E of Pu‘u Kamana; moist gulch</td>
<td>1500ft</td>
<td>St. John 11644</td>
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<tr>
<td>Euphorbiaceae</td>
<td>Aleurites moluccana (L.) Willd.</td>
<td>S ridge of Kipapa Gulch</td>
<td>1200–1400ft</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
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<td>Euphorbiaceae</td>
<td>Aleurites moluccana (L.) Willd.</td>
<td>Kipapa Gulch</td>
<td>1000ft</td>
<td>Hosaka 108</td>
<td>12.i.1930</td>
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<td>Euphorbiaceae</td>
<td>Aleurites moluccana (L.) Willd.</td>
<td>S ridge of Kipapa Gulch; lower rain forest along with <em>Bobea elatior</em> and <em>Straussia gaudichaudiana</em> [?]; tree 40ft tall.</td>
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<td>Ozaki 28</td>
<td>23.xi.1953</td>
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<td>Fabaceae</td>
<td>Acacia confusa Merr.</td>
<td>Kipapa Gulch Trail</td>
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<td>Cowan 90</td>
<td>29.ix.1946</td>
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<td>Fabaceae</td>
<td>Chamaecrista nictitans (L.) Moench subsp. patellaria (DC. ex Collad.) H.S. Irwin &amp; Barneby var. glabrata (Vogel) H.S.Irwin &amp; Barneby</td>
<td>Kipapa Trail, 3/4mi from refuge boundary, trailside; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest</td>
<td>493m</td>
<td>Reynolds &amp; Walker 142</td>
<td>15.vi.2006</td>
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<td>Fabaceae</td>
<td>Falcataria moluccana (Miq.) Barneby &amp; J.W.Grimes</td>
<td>Kipapa Gulch, by road</td>
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<td>Edmondson s.n.</td>
<td>2.vii.1944</td>
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<td>Falcataria moluccana (Miq.) Barneby &amp; J.W.Grimes</td>
<td>Kipapa</td>
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<td>Korte s.n.</td>
<td>2.ix.1944</td>
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<tr>
<td>Fabaceae</td>
<td>Falcataria moluccana (Miq.) Barneby &amp; J.W.Grimes</td>
<td>Kipapa Trail, off trail, S of trail, flattened peak of Pu‘u Kamana; disturbed wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest; ~6m tree</td>
<td>460m</td>
<td>Reynolds &amp; Elmore 117b</td>
<td>8.vi.2006</td>
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<tr>
<td>Family</td>
<td>Scientific name</td>
<td>Locality/Habitat/Plt description</td>
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<td>Collector</td>
<td>Coll date</td>
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<td>Fabaceae</td>
<td>Indigofera suffruticosa Mill.</td>
<td>S Ridge of Kipapa Gulch; rocky grassland</td>
<td>1400ft</td>
<td>Chang s.n.</td>
<td>15.v.1932</td>
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<td>Lythraceae</td>
<td>Cuphea carthagensis (Jacq.) J.F.Macbr.</td>
<td>S ridge of Kipapa Gulch, Zone 2</td>
<td>1200–1400ft</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Lythraceae</td>
<td>Cuphea carthagensis (Jacq.) J.F.Macbr.</td>
<td>Kipapa Trail, ~2mi. from refuge boundary, in center of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>516m</td>
<td>Reynolds 218</td>
<td>20.vii.2006</td>
</tr>
<tr>
<td>Melastomataceae</td>
<td>Clidemia hirta (L.) D.Don</td>
<td>Kipapa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest, Psidium cattleianum; ~25cm shrub; in patches</td>
<td>441m</td>
<td>Reynolds &amp; Kagawa 53b</td>
<td>30.v.2006</td>
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<tr>
<td>Melastomataceae</td>
<td>Pterolepis glomerata (Rotth.) Miq.</td>
<td>Kipapa Trail, several meters from refuge boundary, N side of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>452m</td>
<td>Reynolds &amp; Hoffman 88a</td>
<td>1.vi.2006</td>
</tr>
<tr>
<td>Moraceae</td>
<td>Ficus</td>
<td>Kipapa Trail, off trail, S of trail, third drainage E of Pu’u Kamana, W bank; wet Metrosideros-Acacia-Dicranopteris lowland forest, Psidium cattleianum; ~3m tree, shrubby</td>
<td>406m</td>
<td>Reynolds &amp; Suzuki 129b</td>
<td>10.vi.2006</td>
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<td>Myrsinaceae</td>
<td>Ardisia elliptica Thunb.</td>
<td>Kipapa Trail, just under 3/4mi from refuge boundary, off trail, S side, E slope of drainage; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~1.75m tree</td>
<td>465m</td>
<td>Reynolds &amp; Elmore 183</td>
<td>28.vi.2006</td>
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<td>Myrtaceae</td>
<td>Leptospermum scoparium J.R.Forst. &amp; G.Forst.</td>
<td>Kipapa Trail, ~1.25mi from refuge boundary, ridgeline N and perpendicular to trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~50cm shrub</td>
<td>473m</td>
<td>Reynolds &amp; Loomis 202</td>
<td>7.vii.2006</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Melaleuca quinquenervia (Cav.) S.T.Blake</td>
<td>S ridge of Kipapa Gulch, Zone 2</td>
<td>1200ft</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Melaleuca quinquenervia (Cav.) S.T.Blake</td>
<td>Kipapa Gulch, SE ridge; 15ft tall, cultivated</td>
<td>1100ft</td>
<td>Grant 7093</td>
<td>13.vii.1934</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Melaleuca quinquenervia (Cav.) S.T.Blake</td>
<td>S ridge of Kipapa Gulch; grassy flat at the edge of forest; tree 20ft tall</td>
<td>1200ft</td>
<td>Ozaki 25</td>
<td>23.ix.1952</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Melaleuca quinquenervia (Cav.) S.T.Blake</td>
<td>Kipapa Trail, off trail, S of trail, saddle between Pu’u Kamana and peak to E; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~9m tree</td>
<td>454m</td>
<td>Reynolds &amp; Elmore 116b</td>
<td>8.vi.2006</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Melaleuca quinquenervia (Cav.) S.T.Blake</td>
<td>Along Kipapa Gulch; abandoned, grassy, pineapple field; tree</td>
<td>1250ft</td>
<td>Shinohara 2</td>
<td>29.ix.1946</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Melaleuca quinquenervia (Cav.) S.T.Blake</td>
<td>S ridge of Kipapa Gulch</td>
<td>1200ft</td>
<td>Suehiro s.n.</td>
<td>15.v.1932</td>
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<tr>
<td>Family</td>
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<td>Locality/Habitat/Plt description</td>
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<td>Collector</td>
<td>Coll date</td>
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<tr>
<td>Myrtaceae</td>
<td>Melaleuca quinquenervia (Cav.) S.T.Blake</td>
<td>Kïpapa trail; in grassy area, growing in an open stand; tree 15ft high.</td>
<td>1200ft</td>
<td>Urata s.n.</td>
<td>23.xi.1952</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Psidium cattleianum Sabine</td>
<td>S ridge of Kïpapa Gulch</td>
<td></td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Psidium cattleianum Sabine</td>
<td>S ridge of Kïpapa Gulch</td>
<td>1550ft</td>
<td>Chang s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Psidium cattleianum Sabine</td>
<td>SE ridge of Kïpapa Gulch</td>
<td>1100ft</td>
<td>Grant 7091</td>
<td>13.vii.1934</td>
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<tr>
<td>Myrtaceae</td>
<td>Psidium cattleianum Sabine</td>
<td>S ridge of Kïpapa Gulch; lower rain forest; 8ft tree</td>
<td></td>
<td>Ozaki 50</td>
<td>23.xi.1952</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Psidium cattleianum Sabine</td>
<td>Kïpapa Trail, several meters beyond entrance, N side of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~7m tree</td>
<td>444m</td>
<td>Reynolds &amp; Kagawa 58a</td>
<td>30.v.2006</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Psidium cattleianum Sabine</td>
<td>Kïpapa Trail, ~1/2mi from refuge boundary, N side of trail, above trailside bank; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~7m tree</td>
<td>467m</td>
<td>Reynolds &amp; Hoffman 99a</td>
<td>1.vi.2006</td>
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<tr>
<td>Myrtaceae</td>
<td>Psidium guajava L.</td>
<td>Kïpapa Gulch; in valley; tree 10 feet tall</td>
<td>900ft</td>
<td>Hosaka 1040</td>
<td>14.v.1933</td>
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<tr>
<td>Myrtaceae</td>
<td>Syzygium jambos (L.) Alston</td>
<td>Kïpapa Trail, ~1/2mi from refuge boundary, N side of trail, above trailside bank; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~8m tree</td>
<td>1000ft</td>
<td>Hosaka 1037</td>
<td>14.v.1933</td>
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<tr>
<td>Oleaceae</td>
<td>Fraxinus uhdei (Wenz.) Lingelsh.</td>
<td>Kïpapa Trail, 3/4mi from refuge boundary, N side of trail, upslope ~2m off trail; wet Metrosideros-Acacia-Dicranopteris lowland forest; ~8m tree</td>
<td>493m</td>
<td>Reynolds &amp; Walker 141b</td>
<td>15.vi.2006</td>
</tr>
<tr>
<td>Onagraceae</td>
<td>Ludwigia octovalvis (Jacq.) P.H.Raven</td>
<td>Kïpapa; side of stream;1m tall</td>
<td>440m</td>
<td>Hume 89</td>
<td>15.ii.1931</td>
</tr>
<tr>
<td>Onagraceae</td>
<td>Ludwigia octovalvis (Jacq.) P.H.Raven</td>
<td>Waikakalaua Gulch; river bank, moderately damp</td>
<td></td>
<td>Nitta 60</td>
<td>6.iv.1930</td>
</tr>
<tr>
<td>Onagraceae</td>
<td>Ludwigia octovalvis (Jacq.) P.H.Raven</td>
<td>S ridge of Kïpapa Gulch</td>
<td>1200–</td>
<td>Ryan et al. s.n.</td>
<td>15.v.1932</td>
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<tr>
<td>Onagraceae</td>
<td>Ludwigia octovalvis (Jacq.) P.H.Raven</td>
<td>Waikakalaua Gulch, stream bank</td>
<td>1200ft</td>
<td>St. John 10482</td>
<td>6.iv.1930</td>
</tr>
<tr>
<td>Onagraceae</td>
<td>Ludwigia octovalvis (Jacq.) P.H.Raven</td>
<td>Waikakalaua Gulch; stream bank</td>
<td>1200ft</td>
<td>St. John 10482</td>
<td>6.iv.1930</td>
</tr>
<tr>
<td>Passifloraceae</td>
<td>Passiflora laurifolia L.</td>
<td>Kïpapa Trail, hunter trail in drainage on N side; wet Metrosideros-Acacia-Dicranopteris lowland forest, Cibotium, Psidium cattleianum</td>
<td>413m</td>
<td>Reynolds &amp; Lau 169</td>
<td>22.vi.2006</td>
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<tr>
<td>Family</td>
<td>Scientific name</td>
<td>Locality/Habitat/Plt description</td>
<td>Elev</td>
<td>Collector</td>
<td>Coll date</td>
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<tr>
<td>Rosaceae</td>
<td>Rubus rosifolius Sm.</td>
<td>Kipapa Trail, 1/2mi from refuge boundary, N side of trail; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest</td>
<td>494m</td>
<td>Reynolds &amp; Hoffmann 104a</td>
<td>1.vi.2006</td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>Paederia foetida L.</td>
<td>Kipapa Trail, finger on S side, W slope; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest; on Bobea, growing up through and spreading over thickets of uluhe</td>
<td>432m</td>
<td>Reynolds &amp; Elmore 151</td>
<td>21.vi.2006</td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Brugmansia</td>
<td>2nd N.Fork, Kipapa Gulch; wet</td>
<td>1250ft</td>
<td>Inafuku s.n.</td>
<td>15.ii.1931</td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Solanum mauritianum Scop.</td>
<td>Upper Kipapa watershed, ca 700ft from summit in gulch; wet native forest; 10ft tall tree</td>
<td>2542ft</td>
<td>Williams AMW60</td>
<td>1.ix.2010</td>
</tr>
<tr>
<td>Tiliaceae</td>
<td>Heliocarpus popayanensis Kunth</td>
<td>Kipapa Trail, ~1mi from refuge boundary, trailside; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest; ~1m sapling</td>
<td>517m</td>
<td>Reynolds &amp; Walker 145</td>
<td>15.vi.2006</td>
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<tr>
<td>Ulmaceae</td>
<td>Trema orientalis (L.) Blume</td>
<td>First part of Kipapa Trail; small tree</td>
<td></td>
<td>Kerr 53-O</td>
<td>19.v.1946</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Citharexylum caudatum L.</td>
<td>Kipapa Trail, S of trail, 4th drainage of Pu`u Kamana, W bank; disturbed wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest, <em>Psidium cattleianum</em>; ~3m tree, spindly, moderately branched</td>
<td>433m</td>
<td>Reynolds &amp; Hoffman 135a</td>
<td>13.vi.2006</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Lantana camara L.</td>
<td>S ridge of Kipapa Gulch; Zone 2</td>
<td>1200–1400ft</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Lantana camara L.</td>
<td>Kipapa Gulch S ridge; small bush</td>
<td>1000ft</td>
<td>Hosaka 543</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Lantana camara L.</td>
<td>Kipapa Trail, off trail, S of trail, finger to E of saddle; disturbed wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest; ~75cm shrub, woody</td>
<td>436m</td>
<td>Reynolds &amp; Elmore 113b</td>
<td>8.vi.2006</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Stachytarpheta cayennensis (Rich.) Vahl</td>
<td>Kipapa Trail, ~1.5mi from refuge boundary, S side of trail; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest; partial shade; ~1m herb</td>
<td>507m</td>
<td>Reynolds 192</td>
<td>30.vi.2006</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Stachytarpheta jamaicensis (L.) Vahl</td>
<td>Kipapa Trail, ~1mi from refuge boundary, S side of trail; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest; ~75cm herb</td>
<td>493m</td>
<td>Reynolds &amp; Walker 143b</td>
<td>15.vi.2006</td>
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<tr>
<td>MONOCOTS</td>
<td></td>
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<tr>
<td>Agavaceae</td>
<td>Cordyline fruticosa (L.) A.Chev.</td>
<td>S ridge of Kipapa Gulch</td>
<td>1200–1400ft</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Agavaceae</td>
<td>Cordyline fruticosa (L.) A.Chev.</td>
<td>S ridge of Kipapa Gulch, east of Pu`u Kamana; moist gulch</td>
<td>1500ft</td>
<td>St. John 11642</td>
<td>15.v.1932</td>
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<tr>
<td>Araceae</td>
<td>Alocasia macrorrhizos (L.) G.Don</td>
<td>Kipapa Gulch, S ridge; in streambed</td>
<td>1500ft</td>
<td>Hosaka 1032</td>
<td>14.v.1933</td>
</tr>
<tr>
<td>Family</td>
<td>Scientific name</td>
<td>Locality/Habitat/Plt description</td>
<td>Elev</td>
<td>Collector</td>
<td>Coll date</td>
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<tr>
<td>Arecaceae</td>
<td>Kïpapa Trail, ~1.25mi from refuge boundary, S side of trail, downslope ~2m off trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; under stand of Psidium cattleianum</td>
<td>486m</td>
<td>Reynolds &amp; Suzuki</td>
<td>207</td>
<td>8.vii.2006</td>
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<tr>
<td>Cyperaceae</td>
<td>Eleocharis radicans (Poir.) Kunth</td>
<td>Kïpapa Gulch</td>
<td></td>
<td>Selling 2619</td>
<td>3.vii.1938</td>
</tr>
<tr>
<td>Cyperaceae</td>
<td>Kyllinga brevifolia Rottb.</td>
<td>Kïpapa-Waiʻāhole crest</td>
<td>853m</td>
<td>Grant 7232</td>
<td>7.viii.1934</td>
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<tr>
<td>Cyperaceae</td>
<td>Rhynchospora caduca Elliott</td>
<td>Kïpapa Trail, ~2/3mi from refuge boundary, middle of trail; wet Metrosideros-Acacia-Dicranopteris lowland forest; ~35cm sedge</td>
<td>481m</td>
<td>Reynolds &amp; Elmore</td>
<td>106b</td>
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<tr>
<td>Dioscoreaceae</td>
<td>Dioscorea bulbifera L.</td>
<td>Kïpapa Gulch, S ridge; climbing up 10m tree in open, rather moist woods</td>
<td></td>
<td>St. John 19827</td>
<td>2.x.1938</td>
</tr>
<tr>
<td>Musaceae</td>
<td>Musa</td>
<td>Kïpapa Gulch, streambed</td>
<td>1600ft</td>
<td>Hosaka 783</td>
<td>16.x.1932</td>
</tr>
<tr>
<td>Orchidaceae</td>
<td>Arundina graminifolia (D.Don) Hochr.</td>
<td>Kïpapa Trail, ~2mi from refuge boundary, N side of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest; ~1.25m herb, terrestrial; in clumps</td>
<td>515m</td>
<td>Reynolds 223</td>
<td>20.vii.2006</td>
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<tr>
<td>Orchidaceae</td>
<td>Polystachya concreta (Jacq.) Garay &amp; Sweet</td>
<td>Kïpapa Trail, finger on S side; wet Metrosideros-Acacia-Dicranopteris lowland forest; on Bobea, ~3m from ground, on exposed section of trunk</td>
<td>422m</td>
<td>Reynolds &amp; Elmore</td>
<td>150</td>
</tr>
<tr>
<td>Orchidaceae</td>
<td>Spathoglottis plicata Blume</td>
<td>Kïpapa Trail, just over 1mi. from refuge boundary, next to N side of trail; disturbed wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>463m</td>
<td>Reynolds 185</td>
<td>29.vi.2006</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Andropogon virginicus L.</td>
<td>Kïpapa Gulch Trail, just above parking area; open field</td>
<td></td>
<td>Cowan 72</td>
<td>29.ix.1946</td>
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<tr>
<td>Poaceae</td>
<td>Andropogon virginicus L.</td>
<td>S ridge of Kïpapa Gulch; recently introduced, but now a dominant grass</td>
<td>335m</td>
<td>Webster 1030</td>
<td>5.x.1947</td>
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<tr>
<td>Poaceae</td>
<td>Cortaderia selloana (Schult. &amp; Schult.f.) Asch. &amp; Graebn.</td>
<td>Access road to Kïpapa trail, right side going mauka; between house and trailhead; near stand of Melaleuca; 1m tall keiki growing near mature plants</td>
<td></td>
<td>Clark s.n.</td>
<td>30.x.2008</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Cortaderia selloana (Schult. &amp; Schult.f.) Asch. &amp; Graebn.</td>
<td>Access road to Kïpapa trail, right side going mauka; between house and trailhead; sprouting out of uluhe; 2m tall bunchgrass, one dehiscent inflorescence</td>
<td></td>
<td>Clark s.n.</td>
<td>30.x.2008</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Digitaria ciliaris (Retz.) Koeler</td>
<td>S ridge of Kïpapa Gulch; Zone 2 366–427m</td>
<td></td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
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<tr>
<td>Poaceae</td>
<td>Digitaria ciliaris (Retz.) Koeler</td>
<td>Kïpapa Gulch</td>
<td></td>
<td>Hosaka 461</td>
<td>30.vi.1931</td>
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Bishop Museum  
Appendix D-6  
Hawaii Biological Survey
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<tr>
<th>Family</th>
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<th>Locality/Habitat/Plt description</th>
<th>Elev</th>
<th>Collector</th>
<th>Coll date</th>
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</thead>
<tbody>
<tr>
<td>Poaceae</td>
<td>Echinochloa crusgalli (L.) P.Beauv.</td>
<td>Kikipa Gulch; wet gully floor</td>
<td>500m</td>
<td>Fosberg</td>
<td>8.viii.1933</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Echinochloa crusgalli (L.) P.Beauv.</td>
<td>Kikipa Gulch; along streambed, wooded forest</td>
<td>518m</td>
<td>Hosaka</td>
<td>8.viii.1933</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Opismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz</td>
<td>Kikipa Gulch Trail</td>
<td>305m</td>
<td>Cowan</td>
<td>29.ix.1946</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Opismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz</td>
<td>Main streambed, Kikipa Gulch</td>
<td>305m</td>
<td>Hosaka</td>
<td>10.vii.1932</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Opismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz</td>
<td>Ridge S of Kikipa Gulch</td>
<td>610m</td>
<td>Morley</td>
<td>10.xi.1933</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Opismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz</td>
<td>Kikipa Trail, drainage on S side, in wash; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest, <em>Psidium cattleianum</em></td>
<td>445m</td>
<td>Reynolds et al.</td>
<td>20.vi.2006</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Paspalum conjugatum P.J.Bergius</td>
<td>S ridge of Kikipa Gulch; Zone 2</td>
<td>366–427m</td>
<td>Bryan et al. s.n.</td>
<td>15.v.1932</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Paspalum conjugatum P.J.Bergius</td>
<td>Kikipa Gulch; <em>Metrosideros-Antidesma</em> forest</td>
<td>427m</td>
<td>Grant</td>
<td>6.viii.1934</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Paspalum conjugatum P.J.Bergius</td>
<td>Kikipa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest</td>
<td>443m</td>
<td>Reynolds &amp; Kagawa</td>
<td>30.v.2006</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Pennisetum polystachion (L.) Schult.</td>
<td>Kikipa Gulch</td>
<td></td>
<td>Lyon s.n.</td>
<td>5.iii.1948</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Sacciolepis indica (L.) Chase</td>
<td>Kikipa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest</td>
<td>454m</td>
<td>Reynolds &amp; Kagawa</td>
<td>30.v.2006</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Setaria palmifolia (J.König) Stapf</td>
<td>Kikipa Trail, ~130m from refuge boundary; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest; dense patches</td>
<td>450m</td>
<td>Reynolds et al.</td>
<td>31.v.2006</td>
</tr>
<tr>
<td>Poaceae</td>
<td>Setaria parviflora (Poir.) Kerguélen</td>
<td>Kikipa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest</td>
<td>454m</td>
<td>Reynolds &amp; Kagawa</td>
<td>30.v.2006</td>
</tr>
<tr>
<td>Zingiberaceae</td>
<td>Hedychium flavescens Carey ex Roscoe</td>
<td>Kikipa Gulch; along streambed</td>
<td>305m</td>
<td>Hosaka</td>
<td>10.vii.1932</td>
</tr>
<tr>
<td>Zingiberaceae</td>
<td>Zingiber zerumbet (L.) Sm.</td>
<td>Kikipa Gulch, main streambed</td>
<td>305m</td>
<td>Hosaka</td>
<td>n.d.</td>
</tr>
<tr>
<td>Zingiberaceae</td>
<td>Zingiber zerumbet (L.) Sm.</td>
<td>Kikipa Trail, hunter trail in drainage on N side; wet <em>Metrosideros-Acacia-Dicranopteris</em> lowland forest, <em>Cibotium, Psidium cattleianum, Ardisia elliptica</em></td>
<td>413m</td>
<td>Reynolds &amp; Lau</td>
<td>22.vi.2006</td>
</tr>
<tr>
<td>Family</td>
<td>Scientific name</td>
<td>Locality/Habitat/Plt description</td>
<td>Elev</td>
<td>Collector</td>
<td>Coll date</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------</td>
<td>-----------------------------------------------------------------------------------------------</td>
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<td>------------</td>
</tr>
<tr>
<td><strong>GYMNOSPERMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Araucariaceae</td>
<td>Araucaria columnaris (G.Forst.) Hook.f.</td>
<td>Kīpapa Trail, S of trail, peak E of Pu‘u Kamana; wet Metrosideros-Acacia-Dicranopteris lowland forest; ~5m tree, only base remains</td>
<td>462m</td>
<td>Reynolds &amp; Elmore 112b</td>
<td>8.vi.2006</td>
</tr>
<tr>
<td>Araucariaceae</td>
<td>Araucaria columnaris (G.Forst.) Hook.f.</td>
<td>Kīpapa Trail, 150m from refuge boundary, N of trail; wet Metrosideros-Acacia-Dicranopteris lowland forest, <em>Psidium cattleianum</em>; sapling, ~1.25m; reproductively immature</td>
<td>451m</td>
<td>Reynolds et al. 75b</td>
<td>31.v.2006</td>
</tr>
<tr>
<td>Taxodiaceae</td>
<td>Cryptomeria japonica (L.f.) D.Don</td>
<td>O‘ahu Forest NWR, Near summit of Kīpapa drainage, below summit; grove growing in grassy field; <em>Axonopus fissifolius, Plantago pachyphylla</em>; ~15ft tree</td>
<td></td>
<td>Harbin &amp; Wood 039</td>
<td>3.ix.2003</td>
</tr>
<tr>
<td><strong>PTERIDOPHYTES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blechnaceae</td>
<td>Blechnum appendiculatum Wild.</td>
<td>Kīpapa stream.; wet gorge</td>
<td>1000ft</td>
<td>St. John 10017</td>
<td>10xi.1929</td>
</tr>
<tr>
<td>Lindseaeae</td>
<td>Lindsaea ensifolia Sw.</td>
<td>Kīpapa Trail, 200m from refuge boundary, base on S side of trail; wet Metrosideros-Acacia-Dicranopteris lowland forest, <em>Psidium cattleianum</em></td>
<td>438m</td>
<td>Reynolds et al. 77a</td>
<td>31.v.2006</td>
</tr>
<tr>
<td>Marattiaceae</td>
<td>Angiopteris evecta (G.Forst.) Hoffm.</td>
<td>Kīpapa Trail, ~1mi from refuge boundary, N side of trail, ~4–5m off trail; wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>496m</td>
<td>Reynolds 139</td>
<td>14.vi.2006</td>
</tr>
<tr>
<td>Nephrolepidaceae</td>
<td>Nephrolepis brownii (Desv.) Hovenkamp &amp; Miyam.</td>
<td>Kīpapa Gulch; woods</td>
<td>1000ft</td>
<td>Hosaka 215</td>
<td>13.iv.1930</td>
</tr>
<tr>
<td>Polypodiaceae</td>
<td>Phlebodium aureum (L.) J.Sm.</td>
<td>Kīpapa Trail, 1/3mi from refuge boundary, N side of trail; on Metrosideros polymorpha; wet Metrosideros-Acacia-Dicranopteris lowland forest</td>
<td>464m</td>
<td>Reynolds &amp; Hoffman 97a</td>
<td>1.vi.2006</td>
</tr>
<tr>
<td>Pteridaceae</td>
<td>Adiantum raddianum C.Presl</td>
<td>Kīpapa Gulch; in moist place</td>
<td>1200ft</td>
<td>Hosaka 1044</td>
<td>28.v.1933</td>
</tr>
<tr>
<td>Thelypteridaceae</td>
<td>Cyclosorus dentatus (Forsk.) Ching</td>
<td>S ridge of Kīpapa Gulch; rain forest, side of trail</td>
<td>1700ft</td>
<td>Wilson 172</td>
<td>23.xi.1952</td>
</tr>
<tr>
<td>Thelypteridaceae</td>
<td>Cyclosorus dentatus (Forsk.) Ching</td>
<td>Kīpapa Gulch; <em>Metrosideros-Antidesma</em> forest</td>
<td>1500 ft</td>
<td>Grant 7171</td>
<td>08.viii.1934</td>
</tr>
<tr>
<td>Thelypteridaceae</td>
<td>Cyclosorus parasiticus (L.) Farw.</td>
<td>Kīpapa Stream</td>
<td>1000ft</td>
<td>St. John 10013</td>
<td>10.xi.1929</td>
</tr>
<tr>
<td>Thelypteridaceae</td>
<td>Cyclosorus parasiticus (L.) Farw.</td>
<td>Kīpapa Stream; wet gorge</td>
<td>1000ft</td>
<td>St. John 10022</td>
<td>10.xi.1929</td>
</tr>
</tbody>
</table>

*Bishop Museum*  
*Appendix D-8*  
*Hawaii Biological Survey*
APPENDIX E: Field Identification Cards

Plant species identification cards were developed to assist field crews in making reliable identifications of targeted rare native and invasive species in the field, via a combination of photos and written diagnostic characters. The list of species included was based on rarity, historical voucher records in the vicinity of O‘ahu Forest National Wildlife Refuge, and invasive species occurrence data. The field guide is arranged and color-coded by plant form: tree, shrub, herb, fern, or grass/sedge; and by invasive or native status. Each species card includes scientific and common name and plant family; general description, with key characters in boldfaced type; and habitat. A photographic standards section is included to assist in the production of digital images with taxonomically identifiable characters. The cards were laminated for durability under often wet field conditions. Each member of the survey crew was provided a set of the species identification cards for reference in the field.