2010 Rare Plant Survey, O‘ahu Forest National Wildlife Refuge, Waipi‘o, O‘ahu

Clyde Imada, Patti Clifford, and Joel Q.C. Lau

Honolulu, Hawai‘i

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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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 Kīpapa 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* (‘ōhi‘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 gymnocarpa* (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 Kīpapa 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 Ko‘olau 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 O‘ahu. 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 O‘ahu 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.

2010 Rare Plant Survey, O‘ahu Forest National Wildlife Refuge, Waipi‘o, O‘ahu

Hawaii Biological Survey, Bishop Museum

October 2011

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 Kīpapa 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 Kīpapa 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 epipytic 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).*

Fig. 1. *Sadleria squarrosa*.

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

Many botanists have collected in the upper Waikakalaua–Kīpapa 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 Kīpapa drainage. Other prominent collections in the 1930s in the Waikakalaua–Kīpapa 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 Kīpapa 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,*

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 hiiakae* and *M. lydgatei* (alani, Rutaceae); *Phyllostegia hirsuta* and *P. parviflora* (Lamiaceae); *Platanthera holochila* (Orchidaceae); *Platydesma cornuta* var. *cornuta* (Rutaceae); *Polyscias* (formerly *Tetraplasandra*) *gymnocarpa* (‘ohe‘ohe, Araliaceae); *Psychotria hexandra* subsp. *oahuensis* (kōpiko, 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* (ānini, 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 Kīpapa campsite; 2) *Panicum koolauense* (Species of Concern), Kīpapa campsite; 3) *Gardenia mannii* (Endangered), 2 plants, Kīpapa 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 Kīpapa campsite; and 8) *Zanthoxylum oahuense* (Proposed Endangered), 2 plants, ridge west of Kīpapa 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

(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,*

Cyrtandra viridiflora, Euphorbia rockii, Gardenia mannii, Hesperomannia arborescens, Labordia cyrtandrae, Lobelia oahuensis, Melicope lydgatei, Phyllostegia hirsuta, P. parviflora var. *parviflora, Plantago princeps* var. *princeps, Polyscias gymnocarpa, Pteris lidgatei, Viola oahuensis)* and 4 Proposed Endangered *(Cyanea calycina, Melicope hiiakae, Platydesma cornuta* var. *cornuta, Zanthoxylum oahuense)* plant taxa; and for the Proposed Endangered blackline [*Megalagrion nigrohamatum* subsp. *nigrolineatum* (Perkins, 1899)] and crimson [*M. leptodemas* (Perkins, 1899] Hawaiian damselflies (USFWS 2011a). Oahu–Lowland Wet–Unit 9 also contains unoccupied habitat for 16 Endangered *(Adenophorus periens, Cyanea acuminata, C. crispa, C. grimesiana* subsp. *grimesiana, C. truncata, Cyrtandra dentata, C. polyantha, C. subumbellata, Huperzia nutans, Isodendrion longifolium, Lobelia koolauensis, Myrsine juddii, Plantago princeps* var. *longibracteata, Platanthera holochila, Sanicula purpurea, Trematolobelia singularis)* and 8 Proposed Endangered *(Cyanea lanceolata, C. purpurellifolia, Cyrtandra gracilis, C. kaulantha, C. sessilis, C. waiolani, Psychotria hexandra* subsp. *oahuensis, Pteralyxia macrocarpa)* plant taxa*;* and for the Proposed Endangered oceanic Hawaiian damselfly [*Megalagrion oceanicum* (McLachlan, 1883)] (USFWS 2011a).

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‘olaus 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 Ko‘olau Mountains of O‘ahu, 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), Kaipāpa‘u (2 immature), and Kahana–Makaua (7 adult, 7 immature) to the north of O‘ahu Forest NWR; and ‘Aihualama (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 O‘ahu 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 O‘ahu, Moloka‘i, Lāna‘i, 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 Moloka‘i and Lāna‘i). Thus, the current range of *C. grimesiana* subsp. *grimesiana* is O‘ahu and Moloka‘i (Lammers 1998). Currently, there are reportedly five to six individuals in four occurrences in lowland mesic to wet habitats in the Wai‘anae and Ko‘olau Mountains (USFWS 2011a), although USFWS (2010a) reports that the taxon is apparently extinct in the wild in the Ko‘olaus. Once widely distributed throughout the Ko‘olau Mountains (Bishop Museum Herbarium database, accessed 2011), it has recently only been reported in the southeastern Ko‘olaus. Two populations in Kulu‘ī 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 Wai‘alae Iki–Kapakahi (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 O‘ahu 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 Ko‘olaus 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 Ko‘olau Mountains of O‘ahu, and there are currently 9 occurrences totaling between 160 and 260 individuals (USFWS 2011a), primarily in the southern half of the Ko‘olaus (Pu‘u Keahiakahoe, Kōnāhuanui, Wailupe–Pia, but ranging north to Kaluanui, Ma‘akua, ‘Ōpae‘ula, and Poamoho (USFWS 2010a). Bishop Museum vouchers (see Appendix C) record the historic presence of *C. humboldtiana* inside O‘ahu Forest NWR boundaries, and a population of four immature plants was noted during the Hawai‘i Natural Heritage Program (2003) survey of the refuge.

- **Cyanea koolauensis** (hāhā, 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‘olaus. 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 Kaipāpa‘u–Koloa–Kawainui 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–Kawainui 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* (‘ākia). The primary threat at this site is potential competition with weeds.

Fig. 2. Joel Lau with *Cyanea koolauensis*.

- **Cyanea lanceolata** (hāhā, 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‘ahināi‘a) and southern Ko‘olaus (Kulu‘ī–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,

but no recent sightings have been documented.

- **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 Ko‘olau 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 Ma‘akua–Papali Ridge, and is currently extant in the northern Ko‘olau Mountains from Ma‘akua–Kaipapa‘u to Punalu‘u–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 O‘ahu 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 Ko‘olau summit ridge and wet windswept slopes and ridges in *Metrosideros* (‘ōhi‘a) mixed lowland shrubland or *Metrosideros-Dicranopteris* (‘ōhi‘a-uluhe) lowland shrubland (USFWS 2003). Currently, the U.S. Fish and Wildlife Service (USFWS 2011a) reports 6 occurrences with approximately 70 individuals in the Ko‘olaus. The U.S. Army Garrison (2010) reported 48 remaining adults and 16 immatures along the Ko‘olau 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; Waihe‘e–Waimalu: 10 adult; ‘Āhuimanu–Hālawa: 8 adult, 3 immature; and Waimānalo–Wailupe: 6 adult, 4 immature) of O‘ahu Forest NWR. Bishop Museum vouchers (see Appendix C) record the historic presence of *C. st.-johnii* inside O‘ahu 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 Ko‘olau Mountains of O‘ahu (USFWS 2011a). Currently, there are 2 known wild individuals in Kahana Valley, along with outplanted occurrences (Kahana, Makaua, Hakipu‘u) 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 O‘ahu Forest NWR.

- **Cyrtandra dentata** (ha‘iwale, 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-oblanceolate, 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 Waiāhole–Waikāne 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 Kuli‘ou‘ou (USFWS 2009b, 2011a); in 2008, there were reportedly 46 mature individuals in the 2 populations (Plant Extinction Prevention Program 2008).

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 Ko‘olau 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 Waikāne–Schofield Trail in Kahana Valley (75 adult, 15 immature); and the Hawai‘i 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, suborbicolar 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 Ko‘olau 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 Ko‘olau 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–‘Ōpae‘ula (39 adult, 13 immature), Kawainui–Koloa (16 adult, 4 immature), and South Kaukonahua to Kīpapa summit (2 adult). Bishop Museum vouchers (see Appendix C) record the historic presence of *C. viridiflora* inside O‘ahu 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 Kaipāpa‘u and Punalu‘u north of O‘ahu Forest NWR, to Kalihi Valley in the southern Ko‘olaus, at elevations between 240 and 900 meters (800 and 3,000 feet) (Bishop Museum Herbarium database, accessed 2011; USFWS 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 (USFWS 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 (USFWS 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 (USFWS 2003, 2011a). Currently, the U.S. Fish and Wildlife Service (USFWS 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 Kaipāpa‘u (37 adult, 13 immature), Kaukonahua to Kīpapa (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

Fig. 3. *Euphorbia rockii.*

between *Euphorbia rockii* and the closely allied *E. clusiifolia* grows on the margin of the helicopter landing zone at the Kīpapa Manuka platform (see Map 2).

- **Gardenia mannii** (nā‘ū, 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 O‘ahu, mainly in the Ko‘olau Mountains on gulch slopes and bottoms, streambanks, ridge crests, and leeward drainages in lowland mesic to wet habitats, with a small population in the Wai‘anaes (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 Ko‘olau Range north of O‘ahu Forest NWR, primarily from Kaiwikō‘ele–Kamananui–Kawainui (20 adult), Helemano–Poamoho (14 adult), Pe‘ahināi‘a (37 adult, 1 immature), and ‘Ōpae‘ula (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 Kapakahi (U.S. Army Garrison 2010; USFWS 2010a). Bishop Museum vouchers (see Appendix C) record the historic presence of *G. mannii* in O‘ahu 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 O‘ahu, Moloka‘i, Lāna‘i, and Maui. On O‘ahu it occurs largely in the Ko‘olau 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 Ko‘olaus. The U.S. Army Garrison (2010) reported 163 remaining adults and 125 immatures from Kamananui–Kaluanui (56 adult, 46 immature), ‘Ōpae‘ula (9 adult, 15 immature), Kaukonahua (76 adult, 56 immature), and Poamoho (22 adult, 8 immature); historic populations to the south of O‘ahu Forest NWR at Waimano, Hālawa, Kapakahi, 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 O‘ahu 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 Kaua‘i and O‘ahu on open ridges, forested slopes, or cliffs in *Metrosideros* (‘ōhi‘a)-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

2003). 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‘inapua‘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 Ko‘olaus, subsp. *gaudichaudii* in the southern Ko‘olaus—but with an overlap in distribution in the central Ko‘olaus between Pu‘u Pauao and ‘Eleao (within which O‘ahu 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*?

Fig. 4. *Lobelia koolauensis* (May 2005 @ Lobelia Bog).

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 O‘ahu 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 Ko‘olau 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) decribed its presence since 1984 in the following areas along the central to southern Ko‘olau summits: Waikakalaua–Waikāne Ridge south of Pu‘u Ka‘aumakua, Waiawa, Mānana Trail to Kīpapa Trail, Mānana Stream, south of Mānana Summit, summit between Waimano and ‘Aiea, ‘Eleao, ‘Aiea Trail to Hālawa Trail summit, Pu‘u Keahiakahoe, Kōnāhuanui, Mount Olympus, Lanipō on the Kapakahi–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 hiiakae** (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 hiiakae* and was treated as a synonym of *Pelea* (=*Melicope*) *wawraeana;* later, the species was resurrected by Hartley and Stone (1989). Vegetatively, *M. hiiakae* 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. hiiakae* 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. hiiakae* involvement, but no pure *M. hiiakae* 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 Ko‘olau Mountains of O‘ahu, 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: Hau‘ula–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 Kaiwikō‘ele–Kawainui Ridge, and 42 at Kawai Iki and ‘Ōpae‘ula; 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 O‘ahu 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 oblanceolate 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 Ko‘olau 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 Ko‘olaus 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 O‘ahu Forest NWR; the closest recent collections were made at Poamoho around 4 kilometers north of O‘ahu Forest NWR (Bishop Museum Herbarium database, accessed 2011).

- **Phyllostegia hirsuta** (no common name, Lamiaceae, Endangered) is an erect subshrub to scandent 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 Wai‘anae and Ko‘olau Mountains of O‘ahu, as well as montane wet habitats in the Wai‘anaes (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 Ko‘olaus from Helemano–Poamoho–‘Ōpae‘ula (14 adult, 2 immature), Kaluanui (5 adult), and Kaipāpa‘u–Kawainui (9 adult); a small population at Kaukonahua had recently died. Bishop Museum vouchers (see Appendix C) record the historic presence of *P. hirsuta* inside O‘ahu Forest NWR boundaries, but no recent sightings have been documented.

- **Phyllostegia parviflora** (no common name, Lamiaceae, Endangered) is an 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* (Hawai‘i); var. *lydgatei* (Wai‘anae Mountains, O‘ahu); 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‘olaus 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–Waikāne 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 & Hartt s.n.,* 3 July 1938, “summit of Kawailoa–Punalu‘u Trail”; *Selling 2622,* “head of Kīpapa 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

(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 Wailupe 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‘olaus (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, Reynoldsia,* 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‘olaus, *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

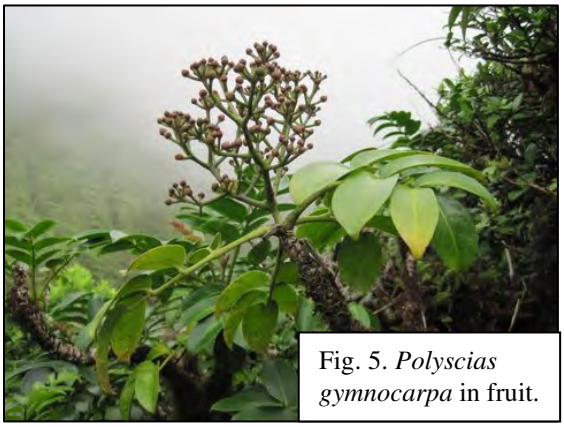

Fig. 5. *Polyscias gymnocarpa* in fruit.

of the refuge into the relatively undisturbed upper wet forest. Habitat degradation by feral pigs is another ever-present concern, although they don’t appear to have yet made many incursions into the wet forest.

- **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 Ko‘olau 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 Kīpapa area; var. *oahuensis,* recorded from the north to central Ko‘olaus; 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 Ko‘olau Mountains: Ma‘akua Gulch, one occurrence of 8–9 individuals; ‘Ōpae‘ula Gulch, 1 individual; and between Kaipāpa‘u 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 Wai‘anae and Ko‘olau 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 Ko‘olau Range from Pūpūkea, ‘Ōpae‘ula, Kawailoa, Kawai Iki, and Makaua in the north; Waimalu in the central Ko‘olaus; and Kalihi, Nu‘uanu, Wai‘alae Iki, and Wailupe further south (Bishop Museum Herbarium database, accessed 2011), and on the summit ridges of the Wai‘anaes. *Pteralyxia macrocarpa* is currently known from 31 occurrences totaling between 233 and 289 individuals in the Wai‘anaes; 7 occurrences totaling 47 individuals in the northern Ko‘olaus; and 2 occurrences totaling 11 individuals in the southern Ko‘olaus (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* (‘ōhi‘a-uluhe) forest, known from O‘ahu, Moloka‘i, 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 Ko‘olau Mountains. The U.S. Army Garrison (2010) reported 9 adults and 5 immatures in the

central to northern Ko‘olaus, ranging from Kawainui to Kawai Iki, Helemano, Kaluanui, and North and South Kaukonahua north of O‘ahu 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 O‘ahu 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 Ko‘olau Mountains, O‘ahu, 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 Ko‘olau numbers range from 24 individuals (USFWS 2011a) to 6 mature and 71 immature plants (U.S. Army Garrison 2010) concentrated in the northern Ko‘olaus from north of Pu‘u Pauao (21 immature), Poamoho (2 adult, 10 immature), and the Schofield–Waikāne Trail summit (2 adult, 40 immature), with a small population on the Wailupe–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 O‘ahu 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 Ko‘olau Mountains, O‘ahu (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 Pu‘u Keahiakahoe, Kōnāhuanui, and Pu‘u 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 O‘ahu 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 O‘ahu Forest NWR. In March 2011, Ko‘olau Mountains Watershed Partnership staff documented the presence of 10 plants of *T. singularis* in two locations along the Ko‘olau summit south of the Kīpapa Trail above the Waiawa drainage at 850 meters (2,785 feet) elevation and within the southern border of O‘ahu Forest NWR; several plants were fruiting (Scott Lynch, Ko‘olau 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* (‘ōhi‘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–‘Ōpae‘ula (163 adult, 146 immature), and Kaukonahua (25 adult) north of O‘ahu Forest NWR, and Waimalu–Kahaluu summit (50 adult) south of the refuge. Oahu Lowland Wet Unit 9 includes populations known from the summit between Waiawa 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* (‘ōlapa); 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‘inapua‘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* (‘ōhi‘a hā), *Bobea elatior* (‘ahakea lau nui), and *Wikstroemia oahuensis* (‘ākia); and a smaller immature tree growing mid-slope on a steep uphill climb, 707 meters (2,320 feet) elevation, with *Machaerina angustifolia* (‘uki), *Metrosideros rugosa* (lehua papa), *Kadua fosbergii* (manono), *Syzygium sandwicensis, Bidens macrocarpa* (ko‘oko‘olau), and *Dicranopteris linearis* (uluhe).

Fig. 6. *Zanthoxylum oahuense*.

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 Kīpapa/Manuka Platform Base Camp/Landing Zone). Map 2 (p. 54) pinpoints the base camps and survey routes. While the established Kīpapa 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/O‘ahu Early Detection). Helicopter drop at Waipi‘o (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 (Ko‘olau Mountains Watershed Partnership); Danielle Frohlich, Alex Lau (O‘ahu Invasive Species Committee/O‘ahu Early Detection); Matt Stelmach (U.S. Fish and Wildlife Service). Helicopter drop at Kīpapa (Manuka) Platform LZ for 4-day botanical survey of ridges and valleys in the vicinity of, and to the north of, Kīpapa 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 O‘ahu 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).

Fig. 7. Kīpapa drainage looking toward the Ko‘olau summit.

Lowland Wet Forests

Metrosideros/Dicranopteris (‘Ōhi‘a/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* (‘ōhi‘a lehua), *Kadua* spp. (manono), *Myrsine* spp. (kōlea), *Syzygium sandwicensis* (‘ōhi‘a hā), *Bobea elatior* (‘ahakea lau nui), and *Ilex anomala* (kāwa‘u). Some alien plant species noted in this community are *Pterolepis glomerata*, *Axonopus fissifolius* (narrow-leaved carpetgrass), *Clidemia hirta* (Koster’s curse), and *Rubus rosifolius* (thimbleberry).

Metrosideros (‘Ōhi‘a) Lowland Wet Forest: The main valley of Kīpapa 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‘awa), *Syzygium sandwicensis, Psychotria* spp. (kōpiko), and *Melicope* spp. (alani). The understory is comprised of few shrubs, including *Wikstroemia oahuensis* (‘ākia), *Broussaisia arguta* (kanawao), *Pipturus albidus* (māmaki), and *Clidemia hirta*. Ferns such as *Cibotium* spp. (hāpu‘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. (‘ōhelo), *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 platyphyllum* (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 *Broussaisia 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.,

Trematolobelia macrostachys (koli‘i), *Axonopus fissifolius, Clidemia hirta,* and *Pterolepis glomerata. Labordia hosakana* (kāmakahala) and *Lobelia koolauensis/gaudichaudii* were noted in this habitat.

Ko‘olau Prostrate Metrosideros (‘Ōhi‘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 Ko‘olau 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*. Ko‘olau Prostrate *Metrosideros* Community occurrences are known only from the Ko‘olau Mountains from Koloa Gulch in the north to Moanalua in the south. The occurrences have been observed primarily to the lee of the Ko‘olau 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.

Fig. 8. Prostrate *Metrosideros* Community.

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* (‘Ōhi‘a) Montane Wet Mixed Communities. On those islands, prostrate forms of *Metrosideros* occur primarily in montane bogs. Several of the Ko‘olau Prostrate *Metrosideros* Community’s component plant taxa normally found only in montane bogs on the neighbor islands are restricted or almost restricted on O‘ahu to this assemblage. These plants include *Rhynchospora chinensis* subsp. *spiciformis* [first reported from O‘ahu in a similar bog community in the Ko‘olaus north of OFNWR (Gon 1994), and first vouchered from O‘ahu in a prostrate *Metrosideros* habitat off ‘Aiea Ridge Trail (Kennedy et al. 2010)]; *Panicum hillebrandianum* (not previously reported from O‘ahu); *Vaccinium pahalae* (‘ōhelo) [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

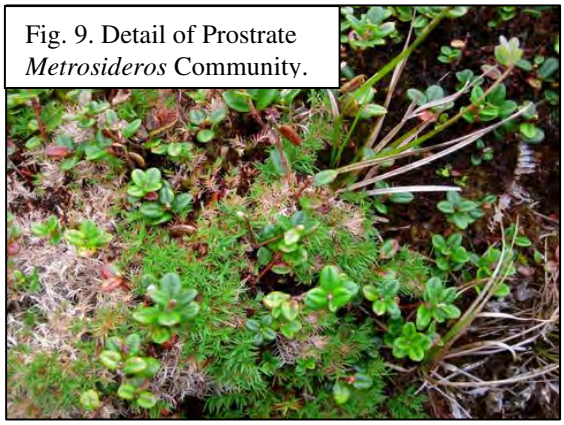

Fig. 9. Detail of Prostrate *Metrosideros* Community.

bright red fruit and strongly revolute leaves (Wagner et al. 1990)]; and a prostrate form of *Leptecophylla tameiameiae* (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‘ā), *Lycopodiella cernua* (wāwae‘iole), and *Dicranopteris linearis* (uluhe); the herbs *Bidens macrocarpa* (ko‘oko‘olau) and *Plantago pachyphylla* (laukahi kuahiwi); 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 (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** (hāhā, 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 macrocarpa* (ko‘oko‘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* (laukahi 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 Kīpapa 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*.

Fig. 10. *Labordia hosakana.*

- **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

moderate to steep slopes in *Metrosideros* 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 Kīpapa 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* (māmaki), 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.

Fig. 11. *Lobelia hypoleuca.*

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

Ko‘olau Mountains of O‘ahu. Bishop Museum vouchers are concentrated in three parts of the Ko‘olaus: north of OFNWR in the Punalu‘u–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 Kuli‘ou‘ou (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 Ko‘olau 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 Kīpapa plant, and they always have intense color on their petioles and proximal midribs; in the central Ko‘olaus 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* (‘ōhi‘a hā), *Clidemia hirta* (Koster's curse), *Sadleria pallida* (‘ama‘u ‘i‘i), *Isachne distichophylla* (‘ohe), and *Dicranopteris linearis* (uluhe).

Fig. 12. *Myrsine* cf. *fosbergii.*

- **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 Ko‘olau Mountains of O‘ahu (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 Ko‘olaus, *Panicum koolauense* has been collected in the wet summit areas ranging from Kaipapa‘u to Punalu‘u, Poamoho, Waikāne–Schofield Trail, Kīpapa, ‘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 Ko‘olaus (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 Ko‘olau 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 Ko‘olau Prostrate *Metrosideros* Community. Wagner et al. (1990) documents its presence only on Kaua‘i, Moloka‘i, Maui, and Hawai‘i, thus this is a previously

Fig. 13. *Panicum koolauense.*

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 Kīpapa 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 Kīpapa 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 hawaiiense* (McLachlan, 1883), the Hawaiian Upland Damselfly, was noted in native riparian *Metrosideros-Dicranopteris* (‘ōhi‘a-uluhe) shrubland in the headwaters of Kīpapa 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

Fig. 14. *Megalagrion oahuense* perched on *Sadleria squarrosa.*

Fig. 15. *Megalagrion hawaiiense* female.

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.

IIId. 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* (shoebutton 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* (kāhili 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), *Falcataria 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, Falcataria 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 Ko‘olau 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 Hawai‘i-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 O‘ahu 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 Hawai‘i State Department of Agriculture’s noxious weed list. This species was rarely seen; it was noted along the Kīpapa 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 Hawai‘i 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** (mule’s-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 Ko‘olau Mountains Watershed Partnership (KMWP) staff during the 2010 survey in the vicinity of the Kīpapa 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 Kīpapa 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 Kīpapa 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 Kīpapa 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 Ko‘olaus, sometimes forming monotypic stands, shading out native plants and preventing their regeneration. *Clidemia hirta* is included on the Hawai‘i 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 Hawai‘i, 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 Ko‘olau 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* (shoebutton 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)

Fig. 16. *Cryptomeria japonica* along Ko‘olau summit.

- **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* (‘ōhi‘a lehua), *Syzygium sandwicense* (‘ōhi‘a 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

Fig. 17. *Dendrobium rhombeum.*

and bromeliads, in wild areas in the state. *Polystachya concreta,* an epiphytic orchid first noted as naturalizing in the Ko‘olaus in 1998 along the Poamoho Trail (Staples et al. 2003), was also noted along this stretch of Kīpapa Trail; it has since been vouchered as far south as Kalihi Valley in the Ko‘olaus, and in the Wai‘anaes 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 Kīpapa 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

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 Kīpapa 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 aggresively 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 Kīpapa 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, waiawī, Myrtaceae, HPWRA=18)— A shrub or small tree 2–6 meters tall, with attractive smooth, peeling bark; leathery, shiny dark green, obovate to elliptic-obovate leaves 3.5–13.5 centimeters long; and fleshy red or yellow, globose to obovoid or ellipsoid berries 2–3 centimeters in diameter

(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 Ko‘olau Prostrate *Metrosideros* (‘Ōhi‘a) 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 Kīpapa 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, Ko‘olau 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 Kīpapa 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 Kīpapa 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 Kalauao 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‘āhole 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** (kāhili 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 poka, 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‘olaus, 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 aggresively 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 Kīpapa 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 Kīpapa 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 Kīpapa 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‘olaus, 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/gaudichaudii* 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. gaudichaudii* 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* (shoebutton 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 Kīpapa 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 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.

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Photo credits:

Danielle Frohlich: Fig. 1 *(Sadleria squarrosa),* Fig. 10 *(Labordia hosakana),* Fig. 17 *(Dendrobium rhombeum)*

Clyde Imada: Fig. 3 *(Euphorbia rockii),* Fig. 4 *(Lobelia 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 hawaiiense)*

Alex Lau: *Lobelia koolauensis* cover shot, Fig. 8 (*Metrosideros* bog uphill shot), Fig. 14 *(Megalagrion oahuense)*

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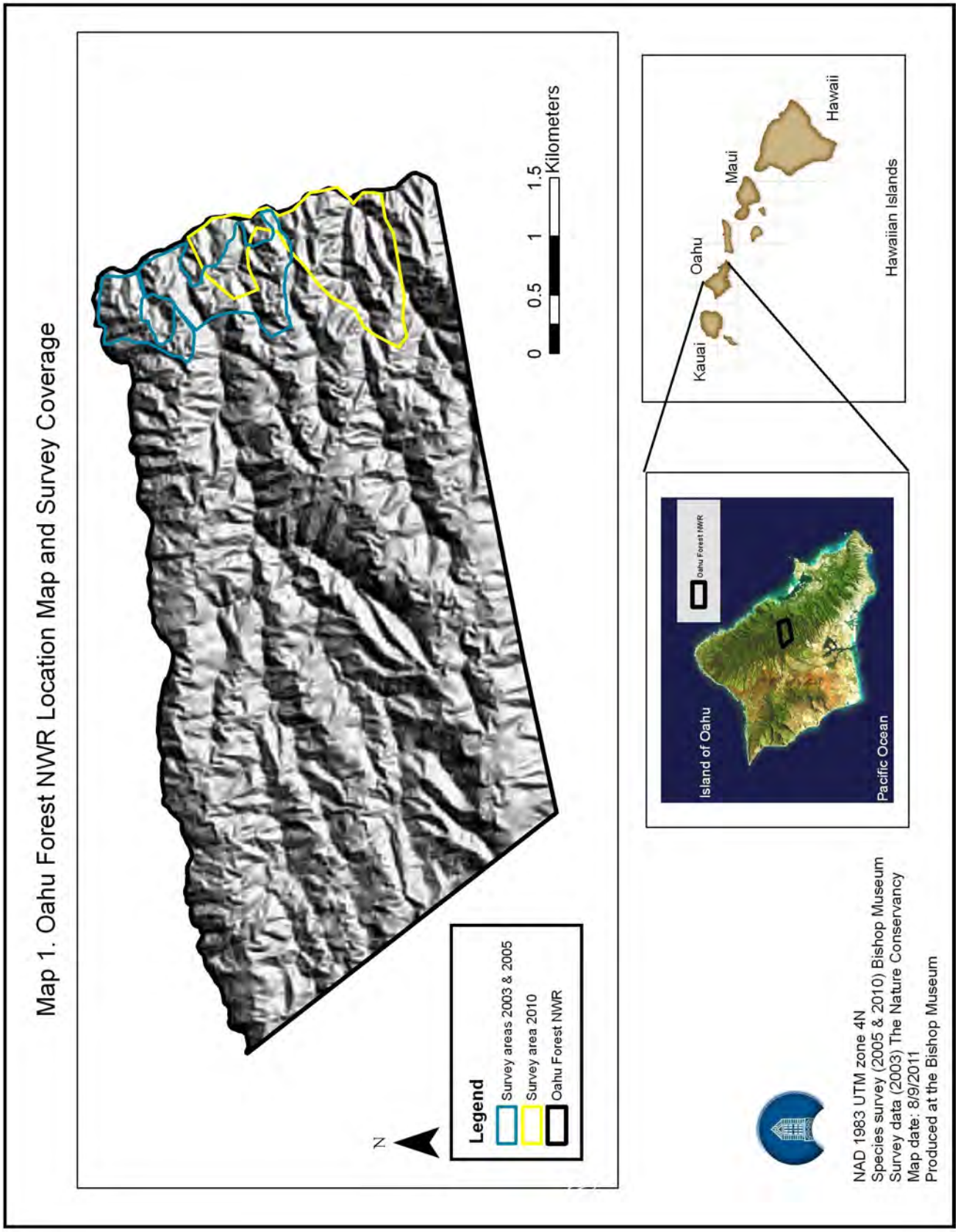
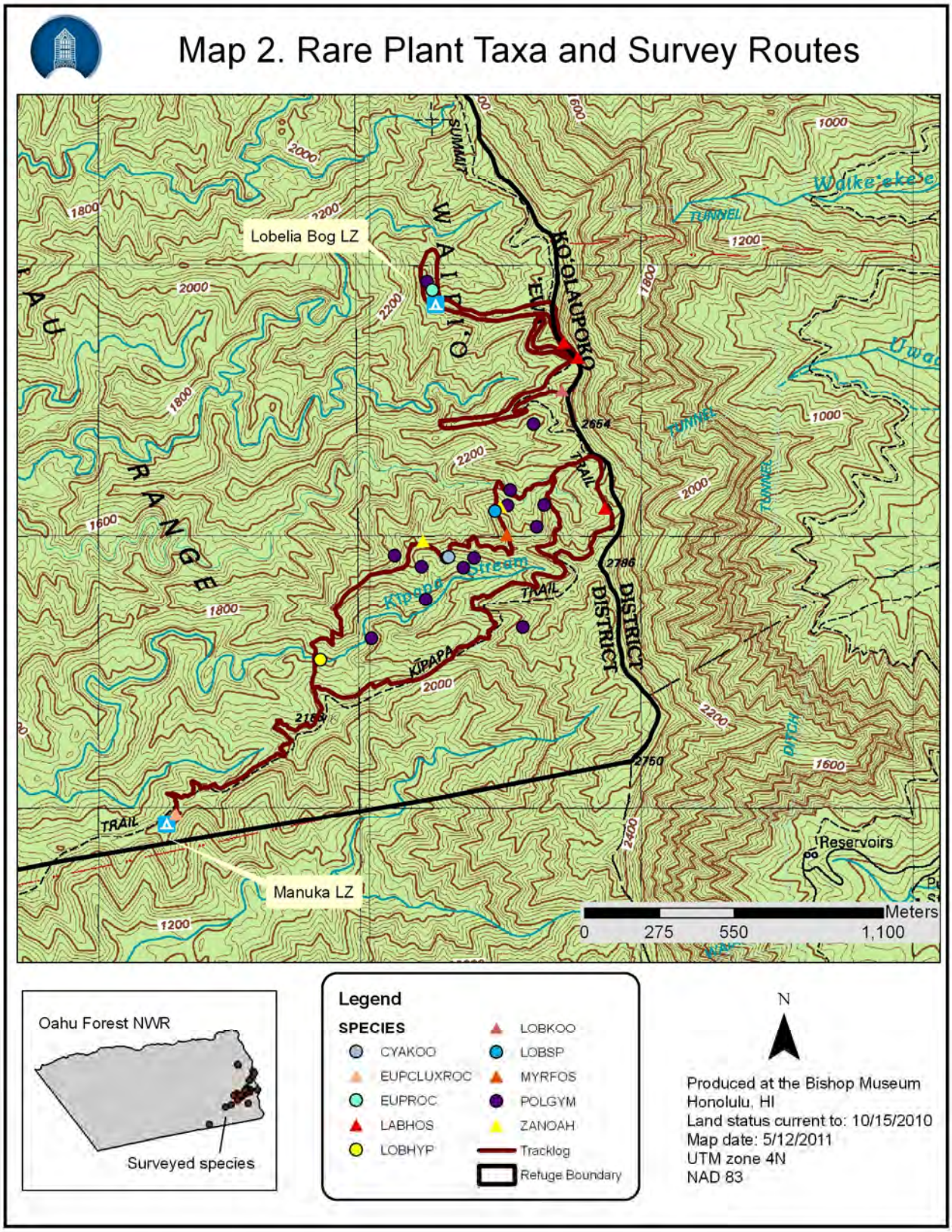
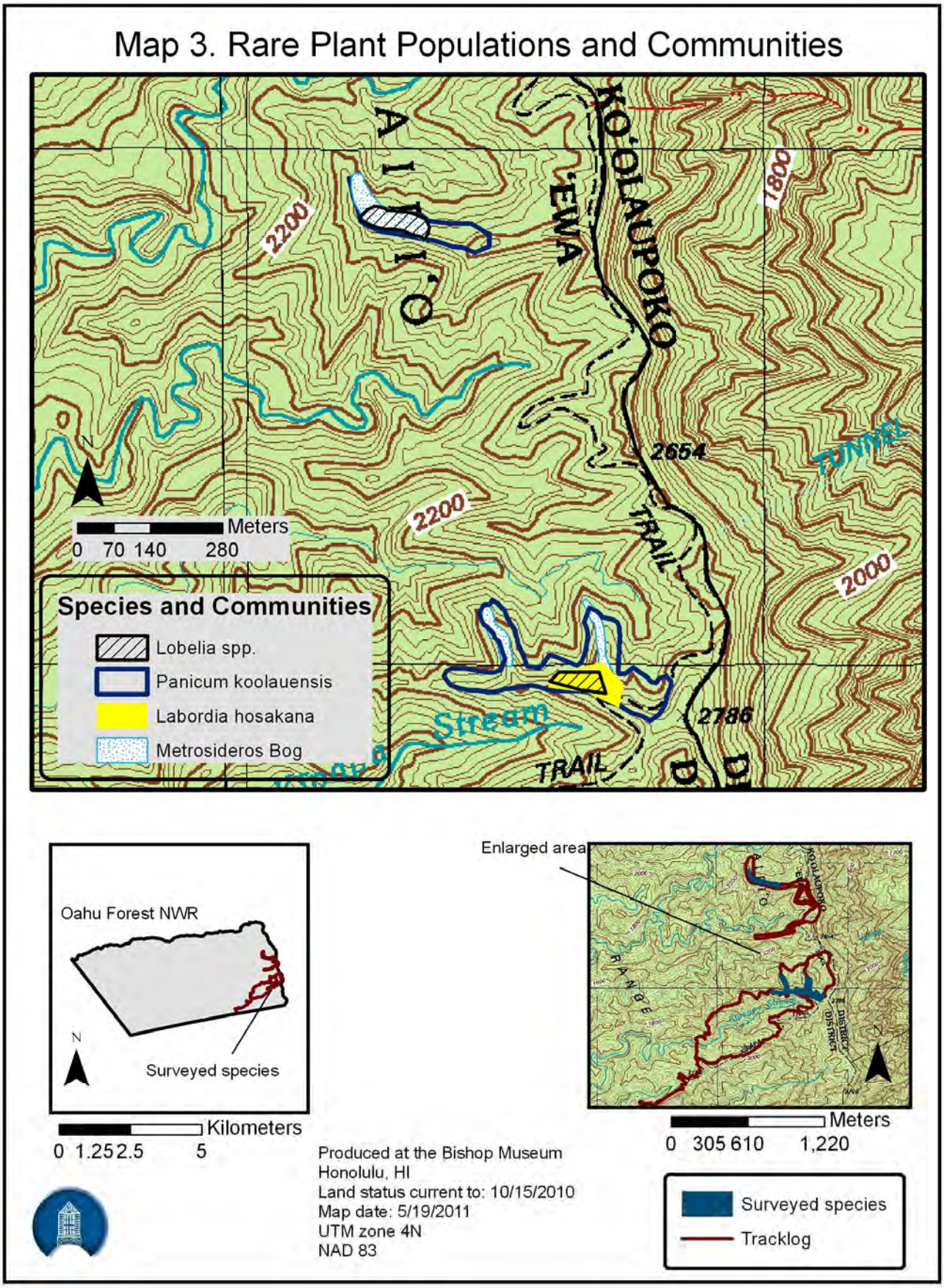
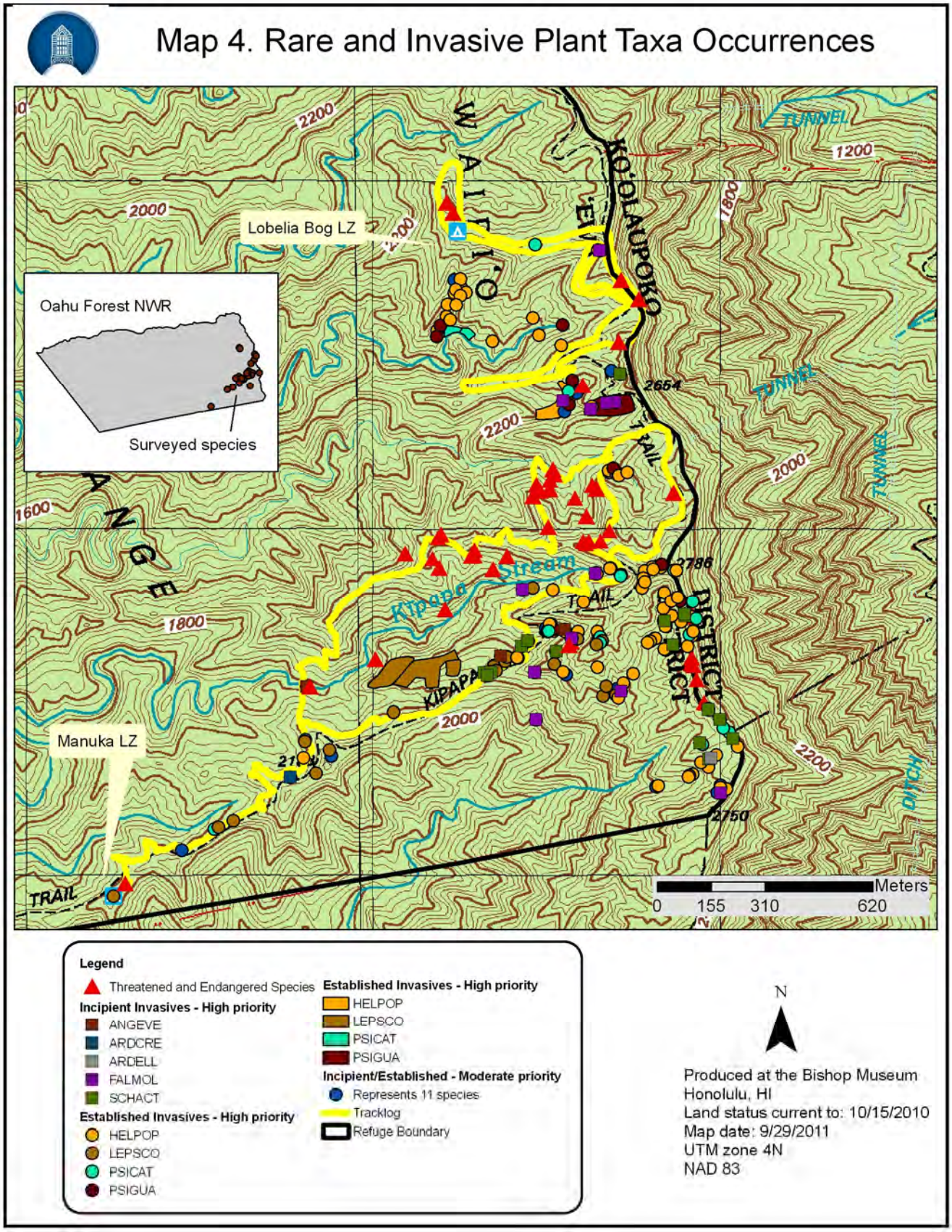
VII. SPECIES ACRONYMS USED IN MAP LEGEND

Acronym	Scientific name	Common name
ANGEVE	Angiopteris evecta	mule’s-foot fern
ARDCRE	Ardisia crenata	Hilo holly
ARDELL	Ardisia elliptica	shoebutton ardisia
CYAKOO	Cyanea koolauensis	hāhā
EUPCLUXROC	Euphorbia clusiifolia x E. rockii	‘akoko
EUPROC	Euphorbia rockii	‘akoko
FALMOL	Falcataria moluccana	albizia
HELPOP	Heliocarpus popayanensis	moho, white moho
LABHOS	Labordia hosakana	kāmakahala
LEPSCO	Leptospermum scoparium	New Zealand tea tree, manuka
LOBHYP	Lobelia hypoleuca	kuhi‘aikamo‘owahie
LOBKOO	Lobelia koolauensis	
LOBSP	Lobelia species	
MYRFOS	Myrsine fosbergii	kōlea
POLGYM	Polyscias gymnocarpa	‘ohe‘ohe
PSICAT	Psidium cattleianum	strawberry guava, waiawī ‘ula‘ula
PSIGUA	Psidium guajava	common guava
SCHACT	Schefflera actinophylla	octopus tree, umbrella tree
ZANOAH	Zanthoxylum oahuense	a‘e, mānele


Map 1. Oahu Forest NWR Location Map and Survey Coverage
N
Legend
Survey areas 2003 & 2005
Survey area 2010
Oahu Forest NWR
0 0.5 1 1.5 Kilometers
Island of Oahu
Oahu Forest NWR
Pacific Ocean
Kauai
Oahu
Maui
Hawaii
Hawaiian Islands
NAD 1983 UTM zone 4N
Species survey (2005 & 2010) Bishop Museum
Survey data (2003) The Nature Conservancy
Map date: 8/9/2011
Produced at the Bishop Museum


Map 2. Rare Plant Taxa and Survey Routes
Lobelia Bog LZ
Manuka LZ
KO'OLAUPOKO
DISTRICT
TRAIL
KIPAPA
Reservoirs
Meters
0
275
550
1,100
Oahu Forest NWR
Surveyed species
Legend
SPECIES
CYAKOO
EUPCLUXROC
EUPROC
LABHOS
LOBHYP
LOBKOO
LOBSP
MYRFOS
POLGYM
ZANOAH
Tracklog
Refuge Boundary
N
Produced at the Bishop Museum
Honolulu, HI
Land status current to: 10/15/2010
Map date: 5/12/2011
UTM zone 4N
NAD 83


Map 3. Rare Plant Populations and Communities
A I I I O
KO'OLAUPOKO
'EWA
2200
1800
2654
TUNNEL
TRAIL
2000
2786
Stream
N
Meters
0 70 140 280
Species and Communities
Lobelia spp.
Panicum koolauensis
Labordia hosakana
Metrosideros Bog
Oahu Forest NWR
Surveyed species
Kilometers
0 1.25 2.5 5
Enlarged area
Meters
0 305 610 1,220
Produced at the Bishop Museum
Honolulu, HI
Land status current to: 10/15/2010
Map date: 5/19/2011
UTM zone 4N
NAD 83
Surveyed species
Tracklog


Map 4. Rare and Invasive Plant Taxa Occurrences
Lobelia Bog LZ
Manuka LZ
Oahu Forest NWR
Surveyed species
WAIANAE RANGE
KO'OLAUPOKO
KIPAPA
Kipapa Stream
TRAIL
TUNNEL
DITCH
2200
2000
1800
1600
1200
2654
2786
2750
Meters
0 155 310 620
Legend
Threatened and Endangered Species
Incipient Invasives - High priority
ANGEVE
ARDCRE
ARDELL
FALMOL
SCHACT
Established Invasives - High priority
HELPOP
LEPSCO
PSICAT
PSIGUA
Established Invasives - High priority
HELPOP
LEPSCO
PSICAT
PSIGUA
Incipient/Established - Moderate priority
Represents 11 species
Tracklog
Refuge Boundary
N
Produced at the Bishop Museum
Honolulu, HI
Land status current to: 10/15/2010
Map date: 9/29/2011
UTM zone 4N
NAD 83

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)

end Endemic: native, occurring only in the Hawaiian Archipelago

ind Indigenous: native, occurring naturally in the archipelago but also outside of Hawai‘i

ind? Questionably indigenous: probably indigenous, possibly naturalized

nat Naturalized: introduced to the archipelago directly or indirectly by humans since Western contact and reproducing and spreading vegetatively or by seed

pol Polynesian introduction: introduced by original Polynesian settlers, either intentionally or unintentionally, and now naturalized

pol? Questionably Polynesian-introduced: perhaps introduced by original Polynesian settlers, but possibly introduced in historic times

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/.

Weed Risk Assessment (WRA) Designation (from http://www.botany.hawaii.edu/faculty/daehler/wra/full_table.asp)

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.

FAMILY	FULL NAME	STATUS	COMMON NAME	FED ST	WRA SCORE	WRA DESIG
DICOTS						
Apiaceae	Centella asiatica (L.) Urb.	nat	Asiatic pennywort		7	H (Hawai‘i)
Apocynaceae	Alyxia stellata (J.R.Forst. & G.Forst.) Roem. & Schult.	end	maile			
Aquifoliaceae	Ilex anomala Hook. & Arn.	ind	kāwa‘u			
Araliaceae	Cheirodendron platyphyllum (Hook. & Arn.) Seem. subsp. platyphyllum	end	‘ōlapa, lapalapa			
Araliaceae	Cheirodendron trigynum (Gaudich.) A. Heller subsp. trigynum	end	‘ōlapa, lapalapa			
Araliaceae	Schefflera actinophylla (Endl.) Harms	nat	octopus tree, umbrella tree		13	H (Hawai‘i)
Araliaceae	Polyscias gymnocarpa (Hillebr.) Lowry & G.M.Plunkett	end	‘ohe‘ohe	E		
Araliaceae	Polyscias oahuensis (A. Gray) Lowry & G.M.Plunkett	end	‘ohe mauka			
Asteraceae	*Ageratina adenophora (Spreng.) R.M.King & H.Rob.	nat	Maui pāmakani			
Asteraceae	Ageratum conyzoides L.	nat	maile hohono			
Asteraceae	Bidens macrocarpa (A.Gray) Sherff	end	ko‘oko‘olau			
Asteraceae	Conyza bonariensis (L.) Cronquist	nat	hairy horseweed			
Asteraceae	Dubautia laxa Hook. & Arn.	end	na‘ena‘e pua melemele			
Asteraceae	Erechtites valerianifolia (Wolf) DC.	nat	fireweed			
Asteraceae	Erigeron karvinskianus DC.	nat	daisy fleabane		11	H (Hawai‘i)
Asteraceae	Pluchea carolinensis (Jacq.) G.Don	nat	sourbush		15	H (Hawai‘i)
Asteraceae	Sphagneticola trilobata (L.) Pruski	nat	wedelia		13	H (HPWRA)
Asteraceae	Youngia japonica (L.) DC.	nat	Oriental hawksbeard			
Buddleiaceae	Buddleia asiatica Lour.	nat	butterfly bush		9	H (HPWRA)
Campanulaceae	Clermontia oblongifolia Gaudich. subsp. oblongifolia	end	‘ōhā wai			
Campanulaceae	Clermontia persicifolia Gaudich.	end	‘ōhā wai			
Campanulaceae	Cyanea koolauensis Lammers, Givnish & Sytsma	end	hāhā	E		
Campanulaceae	Lobelia gaudichaudii A.DC.	end		SOC		
Campanulaceae	Lobelia hypoleuca Hillebr.	end	kuhi‘aikamo‘owahie			
Campanulaceae	Lobelia koolauensis (Hosaka & Fosberg) Lammers	end		E		
Campanulaceae	Trematolobelia macrostachys (Hook. & Arn.) Zahlbr.	end	koli‘i			

FAMILY	FULL NAME	STATUS	COMMON NAME	FED ST	WRA SCORE	WRA DESIG
Celastraceae	Perrottetia sandwicensis A.Gray	end	olomea			
Epacridaceae	Leptecophylla tameiameiae (Cham. & Schltdl.) C.M.Weiller	ind	pūkiawe			
Ericaceae	Vaccinium calycinum Sm.	end	‘ōhelo, ‘ōhelo kau lā‘au			
Ericaceae	Vaccinium dentatum Sm.	end	‘ōhelo			
Ericaceae	Vaccinium reticulatum Sm.	end	‘ōhelo, ‘ōhelo ‘ai			
Euphorbiaceae	Antidesma platyphyllum H.Mann var. platyphyllum	end	hame			
Euphorbiaceae	Euphorbia clusiifolia Hook. & Arnott X E. rockii C.N.Forbes	end	‘akoko			
Euphorbiaceae	Euphorbia rockii C.N.Forbes	end	‘akoko	E		
Fabaceae	Acacia koa A.Gray	end	koa			
Fabaceae	Falcataria moluccana (Miq.) Barneby & J.W.Grimes	nat	albizia		8	H (HPWRA)
Flacourtiaceae	Xylosma hawaiiense Seem.	end	maua			
Gesneriaceae	Cyrtandra paludosa Gaudich. var. paludosa	end	ha‘iwale, kanawao ke‘oke‘o			
Gesneriaceae	Cyrtandra propinqua C.N.Forbes	end	ha‘iwale, kanawao ke‘oke‘o			
Goodeniaceae	Scaevola gaudichaudiana Cham.	end	naupaka kuahiwi			
Goodeniaceae	Scaevola glabra Hook. & Arn.	end	‘ohe naupaka			
Goodeniaceae	Scaevola mollis Hook. & Arn.	end	naupaka kuahiwi			
Hydrangeaceae	Broussaisia arguta Gaudich.	end	kanawao, pū‘ahanui			
Lamiaceae	Phyllostegia grandiflora (Gaudich.) Benth.	end	kāpana			
Lamiaceae	Phyllostegia lantanoides Sherff	end				
Loganiaceae	Labordia fagraeoidea Gaudich.	end	kāmakahala			
Loganiaceae	Labordia hosakana (Sherff) W.L.Wagner, D.R.Herbst & Sohmer	end	kāmakahala	SOC		
Loganiaceae	Labordia sessilis A. Gray	end	kāmakahala			
Loganiaceae	Labordia waiolani Wawra	end	kāmakahala			
Lythraceae	Cuphea carthagenensis (Jacq.) J.F.Macbr.	nat	tarweed			
Lythraceae	Lythrum maritimum Kunth	ind?	loosestrife, pūkāmole			
Melastomataceae	*Clidemia hirta (L.) D.Don var. hirta	nat	Koster’s curse			
Melastomataceae	Pterolepis glomerata (Rottb.) Miq.	nat			11	H (Hawai‘i)
Myrsinaceae	*Ardisia elliptica Thunb.	nat	shoebutton ardisia		11	H (Hawai‘i)
Myrsinaceae	Myrsine cf. fosbergii Hosaka	end	kōlea	C		
Myrsinaceae	Myrsine lessertiana A.DC.	end	kōlea lau nui			
Myrsinaceae	Myrsine sandwicensis A.DC.	end	kōlea lau li‘i			

FAMILY	FULL NAME	STATUS	COMMON NAME	FED ST	WRA SCORE	WRA DESIG
Myrtaceae	Leptospermum scoparium J.R.Forst. & G.Forst.	nat	New Zealand tea tree, manuka		3	H (HPWRA)
Myrtaceae	Metrosideros macropus Hook. & Arn.	end	‘ōhi‘a, ‘ōhi‘a lehua, lehua			
Myrtaceae	Metrosideros polymorpha Gaudich. var. glaberrima (H.Lév.) H.St.John	end	‘ōhi‘a, ‘ōhi‘a lehua			
Myrtaceae	Metrosideros polymorpha Gaudich. var. incana (H.Lév.) H.St.John	end	‘ōhi‘a, ‘ōhi‘a lehua			
Myrtaceae	Metrosideros polymorpha Gaudich. var. polymorpha	end	‘ōhi‘a, ‘ōhi‘a lehua			
Myrtaceae	Metrosideros polymorpha Gaudich. var. pumila (A.Heller) J.W.Dawson & Stemmerm.	end	‘ōhi‘a, ‘ōhi‘a lehua			
Myrtaceae	Metrosideros rugosa A.Gray	end	lehua papa			
Myrtaceae	Metrosideros tremuloides (A.Heller) Knuth	end	lehua ‘āhihi, ‘āhihi			
Myrtaceae	Psidium cattleianum Sabine	nat	strawberry guava, waiawī ‘ula‘ula		18	H (Hawai‘i)
Myrtaceae	Psidium guajava L.	nat	common guava		21	H (Hawai‘i)
Myrtaceae	Syncarpia glomulifera (Sm.) Nied.	nat				
Myrtaceae	Syzygium sandwicensis (A.Gray) Nied.	end	‘ōhi‘a hā			
Onagraceae	Ludwigia octovalvis (Jacq.) P.H.Raven	pol?	primrose willow, kāmole			
Oxalidaceae	Oxalis corniculata L.	pol?	yellow wood sorrel			
Piperaceae	Peperomia ellipticibacca C.DC.	end	‘ala‘ala wai nui			
Piperaceae	Peperomia latifolia Miq.	end	‘ala‘ala wai nui			
Piperaceae	Peperomia membranacea Hook. & Arn.	end	‘ala‘ala wai nui			
Pittosporaceae	Pittosporum glabrum Hook. & Arn.	end	hō‘awa			
Plantaginaceae	Plantago pachyphylla A.Gray	end	laukahi kuahiwi			
Rosaceae	Rubus rosifolius Sm.	nat	thimbleberry		10	H (HPWRA)
Rubiaceae	Bobea elatior Gaudich.	end	‘ahakea lau nui			
Rubiaceae	Coprosma longifolia A.Gray	end	pilo			
Rubiaceae	Kadua affinis DC.	end	manono			
Rubiaceae	Kadua centranthoides Hook. & Arn.	end				
Rubiaceae	Kadua fosbergii (W.L.Wagner & D.R.Herbst) W.L.Wagner & Lorence	end	manono			
Rubiaceae	Psychotria fauriei (H.Lév.) Fosberg	end	kōpiko			
Rubiaceae	Psychotria mariniana (Cham. & Schltdl.) Fosberg	end	kōpiko			

FAMILY	FULL NAME	STATUS	COMMON NAME	FED ST	WRA SCORE	WRA DESIG
Rutaceae	Melicope clusiifolia (A.Gray) T.G.Hartley & B.C.Stone	end	alani			
Rutaceae	Melicope hosakae (H.St.John) W.L.Wagner & R.K.Shannon	end	alani			
Rutaceae	Melicope oahuensis (H.Lév.) T.G.Hartley & B.C.Stone	end	alani			
Rutaceae	Melicope rotundifolia (A.Gray) T.G.Hartley & B.C.Stone	end	alani			
Rutaceae	Melicope wawraeana (Rock) T.G.Hartley & B.C.Stone	end	alani			
Rutaceae	Melicope sp. (similar to M. hiiakae)	end	alani			
Rutaceae	Platydesma spathulata (A.Gray) B.C.Stone	end	pilo kea			
Rutaceae	Zanthoxylum oahuense Hillebr.	end	a‘e, mānele	PE		
Sapindaceae	Dodonaea viscosa Jacq.	ind	‘a‘ali‘i			
Thymelaeaceae	Wikstroemia oahuensis (A.Gray) Rock var. oahuensis	end	‘ākia			
Tiliaceae	Heliocarpus popayanensis Kunth	nat	moho, white moho		7	H (HPWRA)
Urticaceae	Boehmeria grandis (Hook. & Arn.) A.Heller	end	‘ākōlea			
Urticaceae	Pipturus albidus (Hook. & Arn.) A.Gray	end	māmaki			
Verbenaceae	Stachytarpheta australis Moldenke	nat	ōwī, oī			
MONOCOTS						
Agavaceae	Cordyline fruticosa (L.) A.Chev.	pol	kī, ti			
Arecaceae	Pritchardia martii (Gaudich.) H.Wendl.	end	loulu hiwa, loulu	SOC		
Cyperaceae	Carex alligata Boott	end				
Cyperaceae	Carex wahuensis C.A.Mey. subsp. wahuensis	end				
Cyperaceae	Kyllinga brevifolia Rottb.	nat	kili‘o‘opu			
Cyperaceae	Machaerina angustifolia (Gaudich.) T.Koyama	ind	‘uki			
Cyperaceae	Machaerina mariscoides (Gaudich.) J. Kern subsp. meyenii (Kunth) T.Koyama	end	‘ahaniu, ‘uki			
Cyperaceae	Rhynchospora caduca Elliott	nat	beak-rush			
Cyperaceae	Rhynchospora chinensis Nees & Meyen subsp. spiciformis (Hillebr.) T.Koyama	ind	kuolohia			
Cyperaceae	Rhynchospora sclerioides Hook. & Arn.	ind	kuolohia			
Juncaceae	Juncus planifolius R.Br.	nat	rush, bog rush			
Liliaceae	Astelia menziesiana Sm.	end	pa‘iniu			

FAMILY	FULL NAME	STATUS	COMMON NAME	FED ST	WRA SCORE	WRA DESIG
Liliaceae	Dianella sandwicensis Hook. & Arn.	ind	‘uki‘uki, ‘uki			
Orchidaceae	Arundina graminifolia (D.Don) Hochr.	nat	bamboo orchid		11	H (HPWRA)
Orchidaceae	Dendrobium rhombeum Lindl.	nat				
Orchidaceae	Polystachya concreta (Jacq.) Garay & Sweet	nat				
Orchidaceae	Spathoglottis plicata Blume	nat	Philippine ground orchid		16	H (HPWRA)
Pandanaceae	Freycinetia arborea Gaudich.	ind	‘ie‘ie			
Poaceae	*Andropogon virginicus L.	nat	broomsedge		20	H (Hawai‘i)
Poaceae	Axonopus fissifolius (Raddi) Kuhlm.	nat	narrow-leaved carpetgrass		16	H (HPWRA)
Poaceae	Isachne distichophylla Munro ex Hillebr.	end	‘ohe			
Poaceae	Isachne pallens Hillebr.	end				
Poaceae	Oplismenus hirtellus (L.) P.Beauv.	nat	basketgrass			
Poaceae	Panicum hillebrandianum Hitchc.	end				
Poaceae	Panicum koolauense H.St.John & Hosaka	end		SOC		
Poaceae	Paspalum conjugatum P.J.Bergius	nat	Hilo grass, sour paspalum		28	H (Hawai‘i)
Poaceae	Paspalum scrobiculatum L.	ind?	ricegrass, mau‘u laiki			
Poaceae	Sacciolepis indica (L.) Chase	nat	Glenwood grass			
Poaceae	Setaria parviflora (Poir.) Kerguélen	nat	yellow foxtail			
Smilacaceae	Smilax melastomifolia Sm.	end	hoi kuahiwi			
GYMNOSPERMS						
Taxodiaceae	Cryptomeria japonica (L.f.) D.Don	nat	sugi pine		-3	L (HPWRA)
PTERIDOPHYTES						
Aspleniaceae	Asplenium contiguum Kaulf. var. contiguum	end				
Athyriaceae	Deparia petersenii (Kunze) M.Kato	nat				
Athyriaceae	Diplazium sandwichianum (C.Presl) Diels	end	hō‘i‘o			
Blechnaceae	Blechnum appendiculatum Willd.	nat				
Blechnaceae	Sadleria cyatheoides Kaulf.	end	‘ama‘u			
Blechnaceae	Sadleria pallida Hook. & Arn.	end	‘ama‘u ‘i‘i			
Blechnaceae	Sadleria squarrosa (Gaudich.) T.Moore	end	‘apu‘u			
Dicksoniaceae	Cibotium glaucum (Sm.) Hook. & Arn.	end	hāpu‘u, hāpu‘u pulu			
Dicksoniaceae	Cibotium menziesii Hook.	end	hāpu‘u ‘i‘i			
Elaphoglossaceae	Elaphoglossum alatum Gaudich.	end	hoe a Māui, ‘ēkaha			

FAMILY	FULL NAME	STATUS	COMMON NAME	FED ST	WRA SCORE	WRA DESIG
Elaphoglossaceae	Elaphoglossum crassifolium (Gaudich.) W.R.Anderson & Crosby	end	hoe a Māui, ‘ēkaha			
Elaphoglossaceae	Elaphoglossum fauriei Copel.	end	hoe a Māui, ‘ēkaha			
Gleicheniaceae	Dicranopteris linearis (Burm f.) Underw. f. linearis	ind	uluhe			
Gleicheniaceae	Diplopterygium pinnatum (Kunze) Nakai	end	uluhe lau nui			
Grammitidaceae	Adenophorus abietinus (D.C.Eaton) K.A.Wilson	end				
Grammitidaceae	Adenophorus haalilioanus (Brack.) K.A.Wilson	end				
Grammitidaceae	Adenophorus hymenophylloides (Kaulf.) Hook. & Grev.	end	pai, palai huna			
Grammitidaceae	Adenophorus pinnatifidus Gaudich. var. pinnatifidus	end				
Grammitidaceae	Adenophorus tamariscinus (Kaulf.) Hook. & Grev. var. tamariscinus	end	wahine noho mauna			
Grammitidaceae	Adenophorus tenellus (Kaulf.) Ranker	end	kolokolo, mahinalua			
Hymenophyllaceae	Hymenophyllum recurvum Gaudich.	end	‘ōhi‘a kū			
Hymenophyllaceae	Hymenophyllum lanceolatum Hook. & Arn.	end	palai hinahina			
Hymenophyllaceae	Vandenboschia cyrtotheca (Hillebr.) Copel.	end				
Lindsaeaceae	Sphenomeris chinensis (L.) Maxon	ind	pala‘ā			
Lycopodiaceae	Huperzia sp.	end				
Lycopodiaceae	Lycopodiella cernua (L.) Pic.Serm.	ind	wāwae‘iole			
Marattiaceae	Angiopteris evecta (G.Forst.) Hoffm.	nat	mule’s-foot fern		8	H (HPWRA)
Nephrolepidaceae	Nephrolepis brownii (Desv.) Hovenkamp & Miyam.	nat				
Nephrolepidaceae	Nephrolepis cordifolia (L.) C.Presl	ind				
Nephrolepidaceae	Nephrolepis exaltata (L.) Schott subsp. hawaiiensis W.H.Wagner	end	kupukupu			
Polypodiaceae	Phlebodium aureum (L.) J.Sm.	nat	laua‘e haole			
Schizaeaceae	Schizaea robusta Baker	end	‘ōali‘i makali‘i			
Selaginellaceae	Selaginella arbuscula (Kaulf.) Spring	end	lepelepe a moa			
Thelypteridaceae	Thelypteris globulifera (Brack.) C.F.Reed	end	palapalai a Kamapua‘a			
Thelypteridaceae	Cyclosorus parasiticus (L.) Farw.	nat				
Thelypteridaceae	Cyclosorus sandwicensis (Brack.) Copel.	end	hō‘i‘o kula			

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).

Current disposition	Old name
Adenophorus tenellus	Grammitis tenella
Alyxia stellata	Alyxia oliviformis
Cyanea calycina	Rollandia lanceolata subsp. calycina
Cyanea crispa	Rollandia crispa
Cyanea humboldtiana	Rollandia humboldtiana
Cyanea koolauensis	Rollandia angustifolia
Cyanea lanceolata	Rollandia lanceolata
Cyanea longiflora	Rollandia longiflora
Cyanea st.-johnii	Rollandia st.-johnii
Cyclosorus parasiticus	Christella parasitica
Cyclosorus sandwicensis	Pneumatopteris sandwicensis
Euphorbia rockii	Chamaesyce rockii
Falcataria moluccana	Paraserianthes falcataria
Hymenophyllum lanceolatum	Sphaerocionium lanceolatum
Hymenophyllum recurvum	Mecodium recurvum
Kadua affinis	Hedyotis terminalis
Kadua centranthoides	Hedyotis centranthoides
Kadua fluviatilis	Hedyotis fluviatilis
Kadua fosbergii	Hedyotis fosbergii
Leptecophylla tameiameiae	Styphelia tameiameiae
Lobelia gaudichaudii	Lobelia gaudichaudii subsp. gaudichaudii
Lobelia koolauensis	Lobelia gaudichaudii subsp. koolauensis
Melicope clusiifolia	Pelea clusiifolia
Melicope hiiakae	Pelea hiiakae
Melicope hosakae	Pelea honoluluensis
Melicope lydgatei	Pelea lydgatei
Melicope oahuensis	Pelea oahuensis
Melicope rotundifolia	Pelea rotundifolia
Melicope wawraeana	Pelea wawraeana
Nephrolepis brownii	Nephrolepis multiflora
Panicum hillebrandianum	Dichanthelium hillebrandianum
Panicum koolauense	Dichanthelium koolauense
Passiflora tarminiana	Passiflora mollissima
Pluchea carolinensis	Pluchea symphytifolia
Polyscias gymnocarpa	Tetraplasandra gymnocarpa
Polyscias oahuensis	Tetraplasandra oahuensis
Setaria parviflora	Setaria gracilis
Sphagneticola trilobata	Wedelia trilobata
Stachytarpheta australis	Stachytarpheta dichotoma
Thelypteris globulifera	Amauropelta globulifera

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 Kīpapa, 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.

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
DICOTS					
Apiaceae	Sanicula purpurea H.St.John & Hosaka	Kīpapa Gulch, on exposed mossy, turfy ridge; bad odor	860m	Fosberg 9734	6.viii.1933
Apiaceae	Sanicula purpurea H.St.John & Hosaka	Kīpapa–Waiāhole crest, *Metrosideros-Cheirodendron* forest	850m	Grant 7224	7.viii.1934
Apiaceae	Sanicula purpurea H.St.John & Hosaka	Kīpapa Gulch, on wet windswept main divide of range		Hosaka 1135	6.viii.1933
Apiaceae	Sanicula purpurea H.St.John & Hosaka	Ridge S of Kīpapa Gulch; rain forest	790m	Morley 74	10.xii.1933
Araliaceae	Polyscias gymnocarpa (Hillebr.) Lowry & G.M.Plunkett	Kīpapa–Waiawa Ridge; *Metrosideros* forest; 15ft tree	792m	Grant 7240	7.viii.1934
Araliaceae	Polyscias gymnocarpa (Hillebr.) Lowry & G.M.Plunkett	Waikakalaua Gulch, along wooded streambed; 35ft tree	305m	Hosaka 301	14.ix.1930
Araliaceae	Polyscias gymnocarpa (Hillebr.) Lowry & G.M.Plunkett	Kīpapa Gulch, S ridge; denuded slope; 25ft tree	762m	Hosaka 688	18.ix.1932
Araliaceae	Polyscias gymnocarpa (Hillebr.) Lowry & G.M.Plunkett	Ridge S of Kīpapa Gulch; moderate rain forest	762m	Morley 64	10.xii.1933
Araliaceae	Polyscias gymnocarpa (Hillebr.) Lowry & G.M.Plunkett	Head of Waiawa Valley 20ft below Kīpapa trail		Rogers s.n.	29.ix.1946
Asteraceae	Hesperomannia arborescens A.Gray	Kīpapa Trail between 4 and 4.5 mileposts; in forest		Degener et al. 10007	2.vi.1935
Asteraceae	Hesperomannia arborescens A.Gray	Kīpapa Trail		Degener et al. 10080	2.vi.1935
Asteraceae	Hesperomannia arborescens A.Gray	Kīpapa Gulch; involucre wine-colored	575m	Fosberg 9791	8.viii.1933
Asteraceae	Hesperomannia arborescens A.Gray	Kīpapa Gulch; tree 15ft tall	503m	Grant 7251	8.viii.1934

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Asteraceae	Hesperomannia arborescens A.Gray	Kīpapa Gulch, S ridge; 15ft tree	549m	Hosaka 619	4.vii.1932
Asteraceae	Hesperomannia arborescens A.Gray	Kīpapa Trail		Kerr sub Degener 19632	30.v.1949
Asteraceae	Hesperomannia arborescens A.Gray	Kīpapa Gulch; plant 5ft tall	518m	Pearsall s.n.	5.vii.1958
Campanulaceae	Cyanea acuminata (Gaudich.) Hillebr.	Kīpapa Gulch, in *Metrosideros-Antidesma* forest; shrub 7ft tall	460m	Grant 7261	3.viii.1934
Campanulaceae	Cyanea acuminata (Gaudich.) Hillebr.	Kīpapa Gulch, S ridge; in streambed	488m	Hosaka 807	16.x.1932
Campanulaceae	Cyanea acuminata (Gaudich.) Hillebr.	Kīpapa Gulch	520m	Hosaka 1185	7.viii.1933
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch; erect, unbranched undershrub 6ft high	457m	Bryan Jr 774	18.ix.1934
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa–Waiau Ridge; *Metrosideros* forest; erect, 3ft tall	548m	Grant 7205	7.viii.1934
Campanulaceae	Cyanea calycina (Cham.) Lammers	Waiakakalaua Gulch	274m	Hosaka 299	14.ix.1930
Campanulaceae	Cyanea calycina (Cham.) Lammers	Waiakakalaua Gulch	366m	Hosaka 302	14.ix.1930
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch, S ridge; moist woods	305m	Hosaka 554	15.v.1932
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch, S ridge; moderately moist gully	305m	Hosaka 573	29.v.1932
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch, S ridge; wet woods	488m	Hosaka 717	18.ix.1932
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch, S ridge; moist gully	335m	Hosaka 1029	14.v.1933
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch, S ridge	518m	Hosaka 1106	2.vii.1933
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch; in denuded depression	823m	Hosaka 1158	6.viii.1933
Campanulaceae	Cyanea calycina (Cham.) Lammers	Kīpapa Gulch; on wooded slope	610m	Hosaka 1192	7.viii.1933
Campanulaceae	Cyanea calycina (Cham.) Lammers	Waiawa–Waipi‘o ridge; rain forest	600m	Macdaniels 15	6.x.1926
Campanulaceae	Cyanea crispa (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa 2nd N branch	305m	Hosaka 217	13.iv.1930
Campanulaceae	Cyanea crispa (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa Gulch, S ridge; in moderately moist gully	275m	Hosaka 568	20.v.1932
Campanulaceae	Cyanea crispa (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa Gulch, in lower forest	305m	Hosaka 982	30.iv.1933
Campanulaceae	Cyanea crispa (Gaudich.)	Kīpapa Gulch; in moist gully	520m	Hosaka 1000	6.v.1933

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
	Lammers, Givnish & Sytsma				
Campanulaceae	Cyanea crispa (Gaudich.) Lammers, Givnish & Sytsma	E. of Pu‘u Kamana; S ridge of Kīpapa Gulch, moist gulch	488m	St. John s.n.	15.v.1932
Campanulaceae	Cyanea crispa (Gaudich.) Lammers, Givnish & Sytsma	Waikakalaua Gulch; flowers reddish purple, one plant 3 m tall	245m	St. John 10469	6.iv.1930
Campanulaceae	Cyanea grimesiana Gaudich. grimesiana	Kīpapa Gulch, in *Acacia* forest	366m	Grant 7275	8.viii.1934
Campanulaceae	Cyanea grimesiana Gaudich. grimesiana	Kīpapa Gulch, along streambed, second N fork	335m	Hosaka 830	13.xi.1932
Campanulaceae	Cyanea grimesiana Gaudich. grimesiana	Kīpapa; near streambed; shrub	425m	Hume 87	15.ii.1931
Campanulaceae	Cyanea humboldtiana (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa Gulch, S ridge, moderately moist gully	305m	Hosaka 516	15.v.1932
Campanulaceae	Cyanea humboldtiana (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa Gulch, S ridge, moderately moist gully	305m	Hosaka 569	15.v.1932
Campanulaceae	Cyanea humboldtiana (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa Gulch, second N fork; along moist streambed	305m	Hosaka 829	13.xi.1932
Campanulaceae	Cyanea humboldtiana (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa Gulch, S ridge, moderately moist gully	305m	Hosaka 1043	15.v.1932
Campanulaceae	Cyanea humboldtiana (Gaudich.) Lammers, Givnish & Sytsma	Waiawa–Waipi‘o ridge; rain forest	500m	Macdaniels 13	6.x.1926
Campanulaceae	Cyanea koolauensis Lammers, Givnish & Sytsma	S ridge of Kīpapa Gulch, 2–3ft off trail, in thicket	518m	Chang s.n.	15.v.1932
Campanulaceae	Cyanea koolauensis Lammers, Givnish & Sytsma	Kīpapa Gulch trail		Cowan 712	5.x.1947
Campanulaceae	Cyanea koolauensis Lammers, Givnish & Sytsma	Kīpapa–Waiau Ridge, in *Metrosideros-Acacia* forest	549m	Grant 7185	7.viii.1934
Campanulaceae	Cyanea koolauensis Lammers, Givnish & Sytsma	Kīpapa-Waiau Ridge, in *Metrosideros* forest	610m	Grant 7283	7.viii.1934
Campanulaceae	Cyanea koolauensis Lammers, Givnish & Sytsma	Kīpapa Gulch, S ridge, on wooded ridge	518m	Hosaka 596	4.vii.1932
Campanulaceae	Cyanea lanceolata (Gaudich.) Lammers, Givnish & Sytsma	Kīpapa Gulch, SE ridge; *Metrosideros-Acacia* forest	374m	Grant 7078	13.vii.1934
Campanulaceae	Cyanea lanceolata	Kīpapa Gulch, 2nd N fork	335m	Hosaka 1027	

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
	(Gaudich.) Lammers, Givnish & Sytsma lanc				
Campanulaceae	Cyanea longiflora (Wawra) Lammers, Givnish & Sytsma	SE ridge, Kīpapa Gulch, growing in *Metrosideros-Acacia* forest	372m	Grant 7087	13.vii.1934
Campanulaceae	Cyanea longiflora (Wawra) Lammers, Givnish & Sytsma	Western division of main ridge, from Waipi‘o to Helemano		Hillebrand s.n.	
Campanulaceae	Cyanea longiflora (Wawra) Lammers, Givnish & Sytsma	Kīpapa Gulch, S ridge, moderately moist gully	305m	Hosaka 516	15.v.1932
Campanulaceae	Cyanea longiflora (Wawra) Lammers, Givnish & Sytsma	Kīpapa Gulch, S ridge, in moist woods	366m	Hosaka 918	5.iii.1933
Campanulaceae	Cyanea longiflora (Wawra) Lammers, Givnish & Sytsma	Waipi‘o		Lydgate s.n.	
Campanulaceae	Cyanea st.-johnii (Hosaka) Lammers, Givnish & Sytsma	Ko‘olau summit, above Kīpapa Gulch	900m	Fosberg & Hosaka 8715	18.ix.1932
Campanulaceae	Cyanea st.-johnii (Hosaka) Lammers, Givnish & Sytsma	Kīpapa-Waiāhole crest, in *Metrosideros-Cheirodendron* forest	855m	Grant 7265	7.viii.1934
Campanulaceae	Cyanea st.-johnii (Hosaka) Lammers, Givnish & Sytsma	Kīpapa Gulch	853m	Hosaka 743	18.ix.1932
Campanulaceae	Cyanea st.-johnii (Hosaka) Lammers, Givnish & Sytsma	Kīpapa Gulch	853m	Hosaka 1159	6.viii.1933
Campanulaceae	Cyanea st.-johnii (Hosaka) Lammers, Givnish & Sytsma	Kīpapa Gulch main divide	853m	Hosaka 1256	7.viii.1934
Campanulaceae	Lobelia gaudichaudii A.DC.	Kīpapa–Waiāhole crest, *Metrosideros-Cheirodendron* forest; ascending 3 ft		Grant 7217	7.viii.1934
Campanulaceae	Lobelia gaudichaudii A.DC.	Kīpapa Gulch, main divide	853m	Hosaka 686	18.ix.1932
Campanulaceae	Lobelia gaudichaudii A.DC.	Kīpapa trail right of Kīpapa Gulch, lower cloud zone, 200 yds from top	823m	Ozaki 561	27.ix.1953
Campanulaceae	Lobelia gaudichaudii A.DC.	Kīpapa Gulch, Waipi‘o-Waiāhole divide, S ridge; flowers claret	853m	St. John 12077	18.ix.1932
Campanulaceae	Lobelia gaudichaudii A.DC.	1st peak S of Pu‘u Ka‘aumakua, windswept in cloud zone	808m	St. John 20252	14.ix.1941
Campanulaceae	Lobelia hypoleuca Hillebr.	Kīpapa Gulch, S ridge, at head of valley in streambed	549m	Hosaka 797	16.x.1932
Campanulaceae	Lobelia oahuensis Rock	Kīpapa Gulch, main divide, on wet open slope; upright plant, 10ft high	853m	Hosaka 685	18.ix.1932
Campanulaceae	Lobelia oahuensis Rock	Kīpapa Gulch, main divide, on wet open slope; upright plant, 8ft high		Hosaka 1156	6.viii.1933

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Euphorbiaceae	Euphorbia rockii C.N.Forbes	Waiawa		Russ s.n.	ii.1930
Euphorbiaceae	Euphorbia rockii C.N.Forbes.	Waiawa, Waikāne Trail		Topping 3271	27.xii.1925
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch, 2nd branch	305m	Hosaka 154	16.ii.1930
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch, S Ridge	518m	Hosaka 606	4.vii.1932
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch, N Ridge, in moist streambed	366m	Hosaka 649	10.vii.1932
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch, S Ridge; near streambed	518m	Hosaka 702	18.ix.1932
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch, 2nd N fork	518m	Hosaka 846	13.xi.1932
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch; moist gully	549m	Hosaka 1021	6.v.1933
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch, S ridge; on wet ridge	640m	Hosaka 1150	6.viii.1933
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch; by stream	610m	St. John 12075	18.ix.1932
Gesneriaceae	Cyrtandra kalihii Wawra	N Fork of Kīpapa Gulch, in dark ravine	366m	Storey 210	13.xi.1932
Gesneriaceae	Cyrtandra kalihii Wawra	Kīpapa Gulch, in small, densely shaded, humid ravine, leading into main stream	457m	Storey 259	11.ii.1935
Gesneriaceae	Cyrtandra viridiflora H.St.John & Storey	Waikāne-Waipi‘o, 1st peak S of Pu‘u Ka‘aumakua, low moist turf, wind-swept windward crest; 5 dm shrub	762m	St. John 20031	7.v.1939
Lamiaceae	Phyllostegia hirsuta Benth.	Kīpapa Trail 1 mile from summit; sprawling; 3ft high		Degener et al. 9977	2.vi.1935
Lamiaceae	Phyllostegia hirsuta Benth.	Waikakalaua Gulch	305m	Hosaka 204	6.iv.1930
Lamiaceae	Phyllostegia hirsuta Benth.	Kīpapa Gulch, 3ft shrub	518m	Hosaka 1011	6.v.1933
Lamiaceae	Phyllostegia hirsuta Benth.	Waikakalau Gulch, near Waikakalaua-Kīpapa divide	457m	Nitta 64	6.iv.1930
Lamiaceae	Phyllostegia parviflora (Gaudich.) Benth.	Kīpapa Gulch, 2nd N fork		Hosaka 1071	11.vi.1933
Lauraceae	Cryptocarya mannii Hillebr.	Kīpapa gulch, lower forest; tree 20ft high	366m	Hosaka 1000	30.iv.1933
Loganiaceae	Labordia cyrtandrae (Baill.) H.St.John	Kīpapa trail to Ko‘olau summit, N-facing slope; in wet forest gully	518m	Degener et al. 10000	2.vi.1935
Loganiaceae	Labordia cyrtandrae (Baill.) H.St.John	Kīpapa Gulch; wet forest; bush 1.5 m tall	450m	Fosberg 9551	12.vi.1933
Loganiaceae	Labordia cyrtandrae (Baill.) H.St.John	Waikakalaua Gulch; in moist gully	457m	Hosaka 205	6.iv.1930
Loganiaceae	Labordia cyrtandrae (Baill.) H.St.John	S ridge, Kīpapa Gulch	457m	Hosaka 602	4.vii.1932
Loganiaceae	Labordia cyrtandrae (Baill.) H.St.John	Kīpapa Gulch; in wet gully; 4ft shrub	518m	Hosaka 1002	6.v.1933
Loganiaceae	Labordia cyrtandrae (Baill.) H.St.John	Kīpapa Gulch, 2nd N fork; in moist gully; 5ft shrub	457m	Hosaka 1062	11.vi.1933
Loganiaceae	Labordia cyrtandrae (Baill.)	Kīpapa Gulch, S ridge; in wet gully;	457m	Hosaka 1063	4.vii.1932

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
	H.St.John	4ft shrub			
Loganiaceae	Labordia hosakana (Sherff) W.L.Wagner, D.R.Herbst & Sohmer	Kīpapa Trail summit		Degener et al. 10152a	2.vi.1935
Loganiaceae	Labordia hosakana (Sherff) W.L.Wagner, D.R.Herbst & Sohmer	Kīpapa Gulch; exposed ridge		Fosberg 9729	6.viii.1933
Loganiaceae	Labordia hosakana (Sherff) W.L.Wagner, D.R.Herbst & Sohmer	Kīpapa-Waiāhole crest; *Metrosideros-Cheirodendron* forest	853m	Grant 7236	7.viii.1934
Loganiaceae	Labordia hosakana (Sherff) W.L.Wagner, D.R.Herbst & Sohmer	Kīpapa Gulch, S ridge; denuded ridge; shrub 4ft high	762m	Hosaka 679	4.vii.1932
Loganiaceae	Labordia hosakana (Sherff) W.L.Wagner, D.R.Herbst & Sohmer	Ridge S of Kīpapa Gulch; rain forest	792m	Morley 71	10.xii.1933
Rubiaceae	Gardenia mannii H.St.John & Kuykendall	Waipi'o-Waiawa Ridge		Degener & Shear 3244	5.iii.1928
Rubiaceae	Gardenia mannii H.St.John & Kuykendall	Kīpapa Gulch, tree 20ft tall	457m	Grant 7170	6.viii.1934
Rubiaceae	Gardenia mannii H.St.John & Kuykendall	Kīpapa Gulch, S ridge	305m	Hosaka 565	29.v.1932
Rubiaceae	Gardenia mannii H.St.John & Kuykendall	Kīpapa Gulch, S ridge	457m	Hosaka 625	4.vii.1932
Rubiaceae	Gardenia mannii H.St.John & Kuykendall	Kīpapa Valley trail, SE edge of valley; in lower rain forest, bottom of gully; tree 40ft high	335m	Kuykendall 116	30.ix.1945
Rubiaceae	Kadua fluviatilis C.N.Forbes	Kīpapa Gulch	305m	Hosaka 150	16.ii.1930
Rubiaceae	Kadua fluviatilis C.N.Forbes	Kīpapa Gulch N ridge, moist gully	274m	Hosaka 566	29.v.1932
Rubiaceae	Kadua fluviatilis C.N.Forbes	Kīpapa Gulch 2nd N fork		Hosaka 836	13.xi.1932
Rubiaceae	Kadua fluviatilis C.N.Forbes	Kīpapa Gulch, near stream	425m	Hume 85	11.ii.1931
Rubiaceae	Kadua fluviatilis C.N.Forbes	Kīpapa Gulch		Koike s.n.	15.ii.1931
Rubiaceae	Kadua fluviatilis C.N.Forbes	2nd N fork, Kīpapa Gulch; flowers white	427m	St. John 11023	15.ii.1931
Rubiaceae	Kadua fluviatilis C.N.Forbes	N Fork, Kīpapa Gulch	335–427m	Storey 115	15.ii.1931
Rubiaceae	Morinda trimera Hillebr.	Kīpapa Gulch S ridge	488m	Hosaka 963	16.iv.1933
Rubiaceae	Morinda trimera Hillebr.	2nd N fork, Kīpapa Gulch, streambed	152m	Hosaka 1075	11.vi.1933
Rubiaceae	Morinda trimera Hillebr.	Waiawa		Russ s.n.	ii.1930
Rubiaceae	Psychotria hexandra H.Mann subsp. oahuensis	2nd N fork, Kīpapa Gulch, wet forest; 8 m tree	450m	Fosberg et al. 9567	11.vi.1933

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
	O.Deg. & Fosberg var. hosakana Fosb.				
Rubiaceae	Psychotria hexandra H.Mann subsp. oahuensis O.Deg. & Fosberg var. hosakana Fosb.	Kīpapa Gulch; wet forest, bottom of gulch	600m	Fosberg 9759	7.viii.1933
Rubiaceae	Psychotria hexandra H.Mann subsp. oahuensis O.Deg. & Fosberg var. hosakana Fosb.	Kīpapa Gulch, streambed; 35ft tall tree	518m	Hosaka 1167	7.viii.1933
Rutaceae	Melicope hiiakae (B.C.Stone) T.G.Hartley & B.C.Stone	Kīpapa Gulch; 10ft tall tree; odd fruit	457m	Grant 7258	8.viii.1934
Rutaceae	Melicope hiiakae (B.C.Stone) T.G.Hartley & B.C.Stone	Kīpapa Gulch, S ridge; on wooded ridge	549m	Hosaka 809	16.x.1932
Rutaceae	Melicope lydgatei (Hillebr.) T.G.Hartley & B.C.Stone	Kīpapa Gulch, N ridge; wooded slope	396m	Hosaka 674	10.vii.1932
Rutaceae	Melicope lydgatei (Hillebr.) T.G.Hartley & B.C.Stone	Kīpapa Gulch, S ridge; on moist wooded ridge	549m	Hosaka 820	16.x.1932
Rutaceae	Melicope lydgatei (Hillebr.) T.G.Hartley & B.C.Stone	S ridge of Kīpapa Gulch, E of Pu‘u Kamana; wooded slope; 10ft prostrate shrub	503m	St. John 11686	15.v.1932
Rutaceae	Melicope lydgatei (Hillebr.) T.G.Hartley & B.C.Stone	S ridge of Kīpapa Gulch, on ridge in woods; 15ft fastigiate shrub	457m	St. John 12083	18.ix.1932
Rutaceae	Platydesma cornuta Hillebr.	Kīpapa Gulch, 2nd N fork	335m	Hosaka 844	13.xi.1932
Rutaceae	Platydesma cornuta Hillebr.	Kīpapa Gulch, S ridge; 4ft tall shrub	533m	Hosaka 1017	6.v.1933
Rutaceae	Platydesma cornuta Hillebr.	Waikakalaua Gulch, wooded bank		St. John 10465	6.iv.1930
Rutaceae	Zanthoxylum oahuense Hillebr.	Kīpapa trail, ridge ~1 mi. from summit, rainy		Degener & others 10088	2.vi.1935
Rutaceae	Zanthoxylum oahuense Hillebr.	Kīpapa-Waiawa Ridge. *Metrosideros* forest; 15ft tree	579m	Grant 7190	7,viii,1934
Rutaceae	Zanthoxylum oahuense Hillebr.	Kīpapa Gulch, S ridge, denuded; 10ft tall tree	610m	Hosaka 639	4.vii.1932
Rutaceae	Zanthoxylum oahuense Hillebr.	Kīpapa Gulch, S ridge, denuded; 10ft tall tree	610m	Hosaka 793	4.vii.1932
Rutaceae	Zanthoxylum oahuense Hillebr.	S ridge, Kīpapa Gulch, 10ft tree, on wet ridge	671m	Hosaka 1255	8.viii.1934
Rutaceae	Zanthoxylum oahuense Hillebr.	Waipi‘o-Waiawa Ridge; rain forest	750m	Macdaniels 21	6.x.1926
Rutaceae	Zanthoxylum oahuense Hillebr.	Ridge S of Kīpapa Gulch; moderate forest	640m	Morley 75	10,xii,1933
Rutaceae	Zanthoxylum oahuense Hillebr.	Kīpapa Gulch, S ridge; in low, moist forest; young tree 4m tall		St. John 22667	13,iv,1947
Rutaceae	Zanthoxylum oahuense Hillebr.	Waipi‘o-Waiawa ridge		Swezey s.n.	21.ix.1934

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Rutaceae	Zanthoxylum oahuense Hillebr.	Kīpapa Gulch, S ridge	701m	Yamaguchi 1247	4.vii.1932
Santalaceae	Exocarpos gaudichaudii A.DC.	S ridge of Kīpapa Gulch	533m	Chang s.n.	15.v.1932
Santalaceae	Exocarpos gaudichaudii A.DC.	Waipi‘o-Waiawa ridge		Degener & Shear 3297	5.iii.1928
Santalaceae	Exocarpos gaudichaudii A.DC.	Kīpapa Gulch, S ridge	518m	Hosaka 644	4.vii.1932
Santalaceae	Exocarpos gaudichaudii A.DC.	Kīpapa Gulch	549m	Hosaka 1013	6.v.1933
Santalaceae	Exocarpos gaudichaudii A.DC.	Kīpapa Gulch, S ridge; 20ft tree	518m	Hosaka 1128	23.vii.1933
Santalaceae	Exocarpos gaudichaudii A.DC.	Kīpapa Gulch, S ridge, 20ft tree	488m	Hosaka & St. John 1234	12.xi.1933
Santalaceae	Exocarpos gaudichaudii A.DC.	Waipi‘o-Waiawa Ridge; rain forest	700m	Macdaniels 006	6.x.1926
Santalaceae	Exocarpos gaudichaudii A.DC.	Waipi‘o-Waiawa Ridge	600m	Macdaniels 36	6.x.1926
Santalaceae	Exocarpos gaudichaudii A.DC.	Ridge S of Kīpapa Gulch; much-branching plant	732m	Morley s.n.	10.xii.1933
Santalaceae	Exocarpos gaudichaudii A.DC.	Ridge S of Kīpapa Gulch	732m	Morley 61	10.xii.1933
Santalaceae	Exocarpos gaudichaudii A.DC.	Kīpapa Trail, ~1.25 mi. from boundary, ridgeline N and perpendicular to trail	477m	Reynolds 201a	7.vii.2006
Sapindaceae	Alectryon macrococcus Radlk.	Kīpapa Gulch, S ridge, 30ft tree	366m	Hosaka 857	27.xi.1932
Theaceae	Eurya sandwicensis A.Gray	Kīpapa-Waiawa Ridge spur that runs into Waiawa Valley	442m	Kondo s.n.	23.x.1951
Theaceae	Eurya sandwicensis A.Gray	Waiawa trail, S ridge of Kīpapa Gulch; moist forest; bushy tree 5 m tall	500m	Fosberg & Hosaka 13908	29.v.1937
Theaceae	Eurya sandwicensis A.Gray	Waipi‘o-Waiawa Ridge, shrub 2 m high	600m	Macdaniels 057	6.x.1926
Violaceae	Viola oahuensis C.N.Forbes	Kīpapa Gulch, exposed, turfy ridge	860m	Fosberg 9737	6.viii.1933
Violaceae	Viola oahuensis C.N.Forbes	Kīpapa Gulch, main divide; wet place	853m	Hosaka 712	18.ix.1932
Violaceae	Viola oahuensis C.N.Forbes	Kīpapa Gulch, S ridge; wet place, exposed; plants 1ft tall	670m	Hosaka 1119	9.vii.1933
Violaceae	Viola oahuensis C.N.Forbes	Waipi‘o–Kīpapa Gulch, main divide; wet place; 10in tall	853m	Hosaka 1157	6.viii.1933
Violaceae	Viola oahuensis C.N.Forbes	Waipi‘o–Waiawa Ridge; rain forest	600m	MacDaniels 011	6.x.1926
Violaceae	Viola oahuensis C.N.Forbes	Waipi‘o–Kīpapa Gulch, S ridge; rain forest; upright shrub	792m	Morley s.n.	10.xii.1933
MONOCOTS					

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Joinvilleaceae	Joinvillea ascendens Gaudich. ex Brongn. & Gris ascendens	Kīpapa Gulch; canes 2–3 m tall	500m	Fosberg 9548	12.vi.1933
Joinvilleaceae	Joinvillea ascendens Gaudich. ex Brongn. & Gris ascendens	Kīpapa Gulch, *Metrosideros-Antidesma* forest; 8ft tall	549–610m	Grant 7250	7.viii.1934
Joinvilleaceae	Joinvillea ascendens Gaudich. ex Brongn. & Gris ascendens	S ridge, Kīpapa Gulch	518m	Hosaka 1014	6.v.1933
Joinvilleaceae	Joinvillea ascendens Gaudich. ex Brongn. & Gris ascendens	S ridge, Kīpapa Gulch, on wooded ridge	518m	Hosaka 1104	2.vii.1933
Joinvilleaceae	Joinvillea ascendens Gaudich. ex Brongn. & Gris ascendens	Summit trail between Kīpapa Trail and Pu‘u Ka‘aumakua to the north.	838m	Imada 2005-5	2.v.2005
Joinvilleaceae	Joinvillea ascendens Gaudich. ex Brongn. & Gris ascendens	S ridge, Kīpapa Gulch	549–610m	Yamaguchi 1237	15.v.1932
Orchidaceae	Anoectochilus sandvicensis Lindl.	Kīpapa-Waiawa Ridge, *Metrosideros* forest	579m	Grant 7246	7.viii.1934
Orchidaceae	Anoectochilus sandvicensis Lindl.	Kīpapa Gulch, S ridge; mossy tree trunk	610m	Hosaka 1230	12.xi.1933
Orchidaceae	Liparis hawaiensis H.Mann	S Kīpapa Gulch; ridge, rainforest, on bark of tree	610m	Fosberg 8679	18.ix.1932
Orchidaceae	Liparis hawaiensis H.Mann	Kīpapa Gulch, *Metrosideros, Antidesma*	518m	Grant 7179	7.viii.1934
Orchidaceae	Liparis hawaiensis H.Mann	Waikakalaua Gulch; mossy tree branch 15ft in air	396m	Hosaka 614	14.ix.1930
Orchidaceae	Liparis hawaiensis H.Mann	Between head of Kīpapa and Uwau gulches; mossy trunk	792m	Hosaka & Fosberg 1872	30.v.1937
Orchidaceae	Liparis hawaiensis H.Mann	S ridge, Kīpapa Gulch; mossy trunk	457m	St. John 10570	4.vii.1932
Orchidaceae	Platanthera holochila (Hillebr.) Kraenzl.	Head of Kīpapa Gulch		Selling 2622	3.vii.1938
Poaceae	Panicum koolauense H.St.John & Hosaka	Back of Kīpapa, near summit	762m	Beardsley s.n.	17.iv.1958
Poaceae	Panicum koolauense H.St.John & Hosaka	Kīpapa Trail to summit ridge, on wind- and cloud-swept summit; forming tussocks		Degener et al. 9997	2.vi.1935
Poaceae	Panicum koolauense H.St.John & Hosaka	Ko‘olau summit above Kīpapa Gulch, Waiāhole; windward-facing ledges; in tufts and mats betw. rocks	900m	Fosberg 8671	18.ix.1932
Poaceae	Panicum koolauense H.St.John & Hosaka	Kīpapa Gulch, on wet exposed ridge; dense turf	860m	Fosberg 9746	8.vi.1933
Poaceae	Panicum koolauense H.St.John & Hosaka	Main divide, crest of Ko‘olau Mts., betw. Uwau Gulch and Kīpapa Gulch; forming tussocks	800m	Fosberg 13918	30-31.v.1937

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Poaceae	Panicum koolauense H.St.John & Hosaka	Kīpapa-Waiāhole crest, *Metrosideros-Antidesma* forest	853m	Grant 7219	7.viii.1934
Poaceae	Panicum koolauense H.St.John & Hosaka	Main divide, Kīpapa Gulch, on wet windswept ridge	853m	Hosaka 630	4.vii.1932
Poaceae	Panicum koolauense H.St.John & Hosaka	Main divide, Kīpapa Gulch, on wet denuded ridge; forming mat	853m	Hosaka 709	18.ix.1932
Poaceae	Panicum koolauense H.St.John & Hosaka	Main divide, Kīpapa Gulch, forming mat	853m	Hosaka 1154	6.viii.1933
Poaceae	Panicum koolauense H.St.John & Hosaka	Kīpapa-Waiāhole summit		Kerr s.n.	4.vii.1946
Poaceae	Panicum koolauense H.St.John & Hosaka	Kīpapa Gulch, ridge on right-hand side; forming one large cushion	366–610m	Kondo s.n.	14.iv.1946
Poaceae	Panicum koolauense H.St.John & Hosaka	Ridge S of Kīpapa Gulch	792m	Morley 56	10.xii.1933
Poaceae	Panicum koolauense H.St.John & Hosaka	On top of ridge at junction of ridge S of Kīpapa Gulch with the main Ko‘olau Ridge; wet forest	853m	Morley 190	10.ii.1935
Poaceae	Panicum koolauense H.St.John & Hosaka	Ridge S of Kīpapa Gulch, densely tufted, 2–3in high	792m	Morley s.n.	10.xii.1933
Poaceae	Panicum koolauense H.St.John & Hosaka	Kīpapa Trail, S ridge of Kīpapa Gulch, in tufts on ground	792m	Ozaki 564	27.ix.1953
PTERIDOPHYTES					
Blechnaceae	Doodia lyonii O.Deg.	Kīpapa Gulch; shady bank above stream	550m	Fosberg 9797	8.viii.1933
Blechnaceae	Doodia lyonii O.Deg.	Kīpapa Gulch, streambed	460m	Hosaka 803	16.x.1932
Blechnaceae	Doodia lyonii O.Deg.	Kīpapa Stream; damp gorge	305m	St. John 10012	10.xi.1929
Blechnaceae	Doodia lyonii O.Deg.	Kīpapa; Waikakalaua Gulch; steep damp slope	425m	Topping sub Degener 5895	6.iv.1930

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 Kīpapa, Waikakalaua, and Waiawa stream drainages.

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
DICOTS					
Anacardiaceae	Anacardium occidentale L.	Kīpapa Gulch; small trees at edge of forest		Bryan s.n.	27.iv.1941
Anacardiaceae	Anacardium occidentale L.	Kīpapa Gulch		Cowan 88	29.ix.1946
Anacardiaceae	Anacardium occidentale L.	S ridge of Kīpapa Gulch; dry forest	381m	Shinohara 9	9.ix.1946
Apiaceae	Centella asiatica (L.) Urb.	Kīpapa Trail, ~100m from refuge boundary, along edges of trail; wet lowland	457m	Reynolds et al. 72b	31.v.2006
Apiaceae	Hydrocotyle verticillata Thunb.	S ridge of Kīpapa Gulch	366–427m	Bryan et al. s.n.	15.v.1932
Apiaceae	Hydrocotyle verticillata Thunb.	Kīpapa Gulch, muddy gulch floor	500m	Fosberg 9803	8.viii.1933
Araliaceae	Schefflera actinophylla (Endl.) Harms	Kīpapa Trail, ~2/3mi from refuge boundary, S side of trail, upslope; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~3.5m tree	480m	Reynolds 107b	6.vii.2006
Asteraceae	Ageratina riparia (Regel) R.M.King & H.Rob.	Kīpapa Trail, 0.75mi from refuge boundary, off-trail, ridgeline N and perpendicular to trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	494m	Reynolds & Lynch 200	6.vii.2006
Asteraceae	Crassocephalum crepidioides (Benth.) S.Moore	Kīpapa Trail, ~1/2mi from refuge boundary, S side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	475m	Reynolds & Hoffmann 105b	1.vi.2006
Asteraceae	Emilia fosbergii Nicolson	Kīpapa Gulch, 2nd N fork	381m	Inafuku s.n.	15.ii.1931
Asteraceae	Emilia sonchifolia (L.) DC. var. javanica (Burm.f.) Mattf.	Kīpapa Trail, 1.5mi from refuge boundary, N side of trail, S side of hunter trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	533m	Reynolds 187	29.vi.2006
Asteraceae	Erechtites valerianifolia (Wolf) DC.	Kīpapa Trail, ~3/4mi from refuge boundary, N side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~75cm herb	494m	Reynolds & Hoffmann 136	13.vi.2006
Asteraceae	Erechtites valerianifolia (Wolf) DC.	S ridge of Kīpapa Gulch		Wilbur 244	5.x.1947

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Asteraceae	Pluchea carolinensis (Jacq.) G.Don	Kīpapa Trail, off trail, S of trail, third drainage E of Pu‘u Kamana, W bank; wet lowland forest; *Metrosideros, Acacia, Dicranopteris, Psidium cattleianum;* ~2m shrub	407m	Reynolds & Suzuki 130a	10.vi.2006
Asteraceae	Youngia japonica (L.) DC.	S ridge of Kīpapa Gulch	366–427m	Bryan et al. s.n.	15.v.1932
Asteraceae	Youngia japonica (L.) DC.	Kīpapa-Waiawa Ridge	2200ft	Grant 7201	7.viii.1934
Asteraceae	Youngia japonica (L.) DC.	S ridge Kīpapa Gulch	335m	St. John 10025	10.xi.1929
Buddlejaceae	Buddleja asiatica Lour.	Kīpapa-Waiawa Ridge; *Metrosideros* forest; 5ft shrub	1900ft	Grant 7247	7.viii.1934
Buddlejaceae	Buddleja asiatica Lour.	Kīpapa gulch; streambed	1500ft	Hosaka 785	16.x.1932
Buddlejaceae	Buddleja asiatica Lour.	Kīpapa Gulch; wet region, near river side		Koike s.n.	15.ii.1931
Cannabaceae	Cannabis sativa L.	Kīpapa Gulch		Honolulu Police Dept. s.n.	1980
Convolvulaceae	Ipomoea alba L.	Kīpapa-Waiawa ridge; creek bed	1350ft	Grant 7284	8.viii.1934
Convolvulaceae	Ipomoea alba L.	S ridge of Kīpapa Gulch, E of Pu‘u Kamana; moist gulch	1500ft	St. John 11644	15.v.1932
Euphorbiaceae	Aleurites moluccana (L.) Willd.	S ridge of Kīpapa Gulch	1200–1400ft	Bryan et al. s.n.	15.v.1932
Euphorbiaceae	Aleurites moluccana (L.) Willd.	Kīpapa Gulch	1000ft	Hosaka 108	12.i.1930
Euphorbiaceae	Aleurites moluccana (L.) Willd.	S ridge of Kīpapa Gulch; lower rain forest along with *Bobea elatior* and *Straussia gaudichaudiana* [?]; tree 40ft tall.		Ozaki 28	23.xi.1953
Fabaceae	Acacia confusa Merr.	Kīpapa Gulch Trail		Cowan 90	29.ix.1946
Fabaceae	Chamaecrista nictitans (L.) Moench subsp. patellaria (DC. ex Collad.) H.S. Irwin & Barneby var. glabrata (Vogel) H.S.Irwin & Barneby	Kīpapa Trail, 3/4mi from refuge boundary, trailside; wet *Metrosideros-Acacia-Dicranopteris* lowland forest	493m	Reynolds & Walker 142	15.vi.2006
Fabaceae	Falcataria moluccana (Miq.) Barneby & J.W.Grimes	Kīpapa Gulch, by road		Edmondson s.n.	2.vii.1944
Fabaceae	Falcataria moluccana (Miq.) Barneby & J.W.Grimes	Kīpapa		Korte s.n.	2.ix.1944
Fabaceae	Falcataria moluccana (Miq.) Barneby & J.W.Grimes	Kīpapa Trail, off trail, S of trail, flattened peak of Pu‘u Kamana; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~6m tree	460m	Reynolds & Elmore 117b	8.vi.2006

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Fabaceae	Indigofera suffruticosa Mill.	S Ridge of Kīpapa Gulch; rocky grassland	1400ft	Chang s.n.	15.v.1932
Lythraceae	Cuphea carthagenensis (Jacq.) J.F.Macbr.	S ridge of Kīpapa Gulch, Zone 2	1200–1400ft	Bryan et al. s.n.	15.v.1932
Lythraceae	Cuphea carthagenensis (Jacq.) J.F.Macbr.	Kīpapa Trail, ~2mi. from refuge boundary, in center of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	516m	Reynolds 218	20.vii.2006
Melastomataceae	Clidemia hirta (L.) D.Don	Kīpapa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest, *Psidium cattleianum;* ~25cm shrub; in patches	441m	Reynolds & Kagawa 53b	30.v.2006
Melastomataceae	Pterolepis glomerata (Rottb.) Miq.	Kīpapa Trail, several meters from refuge boundary, N side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	452m	Reynolds & Hoffman 88a	1.vi.2006
Moraceae	Ficus	Kīpapa 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	406m	Reynolds & Suzuki 129b	10.vi.2006
Myrsinaceae	Ardisia elliptica Thunb.	Kīpapa 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	465m	Reynolds & Elmore 183	28.vi.2006
Myrtaceae	Leptospermum scoparium J.R.Forst. & G.Forst.	Kīpapa Trail, ~1.25mi from refuge boundary, ridgeline N and perpendicular to trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~50cm shrub	473m	Reynolds & Loomis 202	7.vii.2006
Myrtaceae	Melaleuca quinquenervia (Cav.) S.T.Blake	S ridge of Kīpapa Gulch, Zone 2	1200ft	Bryan et al. s.n.	15.v.1932
Myrtaceae	Melaleuca quinquenervia (Cav.) S.T.Blake	Kīpapa Gulch, SE ridge;15ft tall, cultivated	1100ft	Grant 7093	13.vii.1934
Myrtaceae	Melaleuca quinquenervia (Cav.) S.T.Blake	S ridge of Kīpapa Gulch; grassy flat at the edge of forest; tree 20ft tall	1200ft	Ozaki 25	23.ix.1952
Myrtaceae	Melaleuca quinquenervia (Cav.) S.T.Blake	Kīpapa Trail, off trail, S of trail, saddle between Pu‘u Kamana and peak to E; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~9m tree	454m	Reynolds & Elmore 116b	8.vi.2006
Myrtaceae	Melaleuca quinquenervia (Cav.) S.T.Blake	Along Kīpapa Gulch; abandoned, grassy, pineapple field; tree	1250ft	Shinohara 2	29.ix.1946
Myrtaceae	Melaleuca quinquenervia (Cav.) S.T.Blake	S ridge of Kīpapa Gulch	1200ft	Suehiro s.n.	15.v.1932

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Myrtaceae	Melaleuca quinquenervia (Cav.) S.T.Blake	Kīpapa trail; in grassy area, growing in an open stand; tree 15ft high.	1200ft	Urata s.n.	23.xi.1952
Myrtaceae	Psidium cattleianum Sabine	S ridge of Kīpapa Gulch		Bryan et al. s.n.	15.v.1932
Myrtaceae	Psidium cattleianum Sabine	S ridge of Kīpapa Gulch	1550ft	Chang s.n.	15.v.1932
Myrtaceae	Psidium cattleianum Sabine	SE ridge of Kīpapa Gulch	1100ft	Grant 7091	13.vii.1934
Myrtaceae	Psidium cattleianum Sabine	S ridge of Kīpapa Gulch; lower rain forest; 8ft tree		Ozaki 50	23.xi.1952
Myrtaceae	Psidium cattleianum Sabine	Kīpapa Trail, several meters beyond entrance, N side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; 7–8m tree	444m	Reynolds & Kagawa 58a	30.v.2006
Myrtaceae	Psidium cattleianum Sabine	Kīpapa		Yoshinaga s.n.	10.xi.1929
Myrtaceae	Psidium guajava L.	Kīpapa Gulch; in valley; tree 10 feet tall	900ft	Hosaka 1040	14.v.1933
Myrtaceae	Syzygium jambos (L.) Alston	Kīpapa Trail, ~1/2mi from refuge boundary, N side of trail, above trailside bank; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~7m tree, moderately thick stands	467m	Reynolds & Hoffman 99a	1.vi.2006
Myrtaceae	Syzygium malaccense (L.) Merr. & L.M.Perry	Kīpapa Gulch; in moist gully; 40ft tree.	1000ft	Hosaka 1037	14.v.1933
Oleaceae	Fraxinus uhdei (Wenz.) Lingelsh.	Kīpapa Trail, 3/4mi from refuge boundary, N side of trail, upslope ~2m off trail; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~8m tree	493m	Reynolds & Walker 141b	15.vi.2006
Onagraceae	Ludwigia octovalvis (Jacq.) P.H.Raven	Kīpapa; side of stream;1m tall	440m	Hume 89	15.ii.1931
Onagraceae	Ludwigia octovalvis (Jacq.) P.H.Raven	Waikakalaua Gulch; river bank, moderately damp		Nitta 60	6.iv.1930
Onagraceae	Ludwigia octovalvis (Jacq.) P.H.Raven	S ridge of Kīpapa Gulch	1200–1400ft	Ryan et al. s.n.	15.v.1932
Onagraceae	Ludwigia octovalvis (Jacq.) P.H.Raven	Waikakalaua Gulch, stream bank	1200ft	St. John 10.482	6.iv.1930
Onagraceae	Ludwigia octovalvis (Jacq.) P.H.Raven	Waikakalaua Gulch; stream bank	1200ft	St. John 10482	6.iv.1930
Passifloraceae	Passiflora laurifolia L.	Kīpapa Trail, hunter trail in drainage on N side; wet *Metrosideros-Acacia-Dicranopteris* lowland forest, *Cibotium, Psidium cattleianum*	413m	Reynolds & Lau 169	22.vi.2006

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Rosaceae	Rubus rosifolius Sm.	Kīpapa Trail, 1/2mi from refuge boundary, N side of trail; wet *Metrosideros-Acacia-Dicranopteris* lowland forest	494m	Reynolds & Hoffmann 104a	1.vi.2006
Rubiaceae	Paederia foetida L.	Kīpapa Trail, finger on S side, W slope; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; on Bobea, growing up through and spreading over thickets of uluhe	432m	Reynolds & Elmore 151	21.vi.2006
Solanaceae	Brugmansia	2nd N.Fork, Kīpapa Gulch; wet	1250ft	Inafuku s.n.	15.ii.1931
Solanaceae	Solanum mauritianum Scop.	Upper Kīpapa watershed, ca 700ft from summit in gulch; wet native forest; 10ft tall tree	2542ft	Williams AMW60	1.ix.2010
Tiliaceae	Heliocarpus popayanensis Kunth	Kīpapa Trail, ~1mi from refuge boundary, trailside; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~1m sapling	517m	Reynolds & Walker 145	15.vi.2006
Ulmaceae	Trema orientalis (L.) Blume	First part of Kīpapa Trail; small tree		Kerr 53-O	19.v.1946
Verbenaceae	Citharexylum caudatum L.	Kīpapa Trail, S of trail, 4th drainage E of Pu‘u Kamana, W bank; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest, *Psidium cattleianum;* ~3m tree, spindly, moderately branched	433m	Reynolds & Hoffman 135a	13.vi.2006
Verbenaceae	Lantana camara L.	S ridge of Kīpapa Gulch; Zone 2	1200–1400ft	Bryan et al. s.n.	15.v.1932
Verbenaceae	Lantana camara L.	Kīpapa Gulch S ridge; small bush	1000ft	Hosaka 543	15.v.1932
Verbenaceae	Lantana camara L.	Kīpapa Trail, off trail, S of trail, finger to E of saddle; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~75cm shrub, woody	436m	Reynolds & Elmore 113b	8.vi.2006
Verbenaceae	Stachytarpheta cayennensis (Rich.) Vahl	Kīpapa Trail, ~1.5mi from refuge boundary, S side of trail; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; partial shade; ~1m herb	507m	Reynolds 192	30.vi.2006
Verbenaceae	Stachytarpheta jamaicensis (L.) Vahl	Kīpapa Trail, ~1mi from refuge boundary, trailside; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~75cm herb	493m	Reynolds & Walker 143b	15.vi.2006
MONOCOTS					
Agavaceae	Cordyline fruticosa (L.) A.Chev.	S ridge of Kīpapa Gulch	1200–1400ft	Bryan et al. s.n.	15.v.1932
Agavaceae	Cordyline fruticosa (L.) A.Chev.	S ridge of Kīpapa Gulch, east of Pu‘u Kamana; moist gulch	1500ft	St. John 11642	15.v.1932
Araceae	Alocasia macrorrhizos (L.) G.Don	Kīpapa Gulch, S ridge; in streambed	1500ft	Hosaka 1032	14.v.1933

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Arecaceae		Kīpapa 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*	486m	Reynolds & Suzuki 207	8.vii.2006
Cyperaceae	Eleocharis radicans (Poir.) Kunth	Kīpapa Gulch		Selling 2619	3.vii.1938
Cyperaceae	Kyllinga brevifolia Rottb.	Kīpapa-Wai'āhole crest	853m	Grant 7232	7.viii.1934
Cyperaceae	Rhynchospora caduca Elliott	Kīpapa Trail, ~2/3mi from refuge boundary, middle of trail; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~35cm sedge	481m	Reynolds 106b	7.vi.2006
Dioscoreaceae	Dioscorea bulbifera L.	Kīpapa Gulch, S ridge; climbing up 10m tree in open, rather moist woods		St. John 19827	2.x.1938
Musaceae	Musa	Kīpapa Gulch, streambed	1600ft	Hosaka 783	16.x.1932
Orchidaceae	Arundina graminifolia (D.Don) Hochr.	Kīpapa Trail, ~2mi from refuge boundary, N side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~1.25m herb, terrestrial; in clumps	515m	Reynolds 223	20.vii.2006
Orchidaceae	Polystachya concreta (Jacq.) Garay & Sweet	Kīpapa Trail, finger on S side; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; on *Bobea,* ~3m from ground, on exposed section of trunk	422m	Reynolds & Elmore 150	21.vi.2006
Orchidaceae	Spathoglottis plicata Blume	Kīpapa Trail, just over 1mi. from refuge boundary, next to N side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	463m	Reynolds 185	29.vi.2006
Poaceae	Andropogon virginicus L.	Kīpapa Gulch Trail, just above parking area; open field		Cowan 72	29.ix.1946
Poaceae	Andropogon virginicus L.	S ridge of Kīpapa Gulch; recently introduced, but now a dominant grass	335m	Webster 1030	5.x.1947
Poaceae	Cortaderia selloana (Schult. & Schult.f.) Asch. & Graebn.	Access road to Kīpapa trail, right side going mauka; between house and trailhead; near stand of *Melaleuca;* 1m tall keiki growing near mature plants		Clark s.n.	30.x.2008
Poaceae	Cortaderia selloana (Schult. & Schult.f.) Asch. & Graebn.	Access road to Kīpapa trail, right side going mauka; between house and trailhead; sprouting out of uluhe; 2m tall bunchgrass, one dehiscent inflorescence		Clark s.n.	30.x.2008
Poaceae	Digitaria ciliaris (Retz.) Koeler	S ridge of Kīpapa Gulch; Zone 2	366–427m	Bryan et al. s.n.	15.v.1932
Poaceae	Digitaria ciliaris (Retz.) Koeler	Kīpapa Gulch		Hosaka 461	30.vi.1931

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
Poaceae	Echinochloa crusgalli (L.) P.Beauv.	Kīpapa Gulch; wet gully floor	500m	Fosberg 9800	8.viii.1933
Poaceae	Echinochloa crusgalli (L.) P.Beauv.	Kīpapa Gulch; along streambed, wooded forest	518m	Hosaka 1213	8.viii.1933
Poaceae	Oplismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz	Kīpapa Gulch Trail	305m	Cowan 80	29.ix.1946
Poaceae	Oplismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz	Main streambed, Kīpapa Gulch	305m	Hosaka 655	10.vii.1932
Poaceae	Oplismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz	Ridge S of Kīpapa Gulch	610m	Morley 62	10.xii.1933
Poaceae	Oplismenus hirtellus (L.) P.Beauv. subsp. hirtellus U.Scholz	Kīpapa Trail, drainage on S side, in wash; wet *Metrosideros-Acacia-Dicranopteris* lowland forest, *Psidium cattleianum*	445m	Reynolds et al. 147	20.vi.2006
Poaceae	Paspalum conjugatum P.J.Bergius	S ridge of Kīpapa Gulch; Zone 2	366–427m	Bryan et al. s.n.	15.v.1932
Poaceae	Paspalum conjugatum P.J.Bergius	Kīpapa Gulch; *Metrosideros-Antidesma* forest	427m	Grant 7174	6.viii.1934
Poaceae	Paspalum conjugatum P.J.Bergius	Kīpapa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	443m	Reynolds & Kagawa 60b	30.v.2006
Poaceae	Pennisetum polystachion (L.) Schult.	Kīpapa Gulch		Lyon s.n.	5.iii.1948
Poaceae	Sacciolepis indica (L.) Chase	Kīpapa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	454m	Reynolds & Kagawa 57a	30.v.2006
Poaceae	Setaria palmifolia (J.Kōnig) Stapf	Kīpapa Trail, ~130m from refuge boundary; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; dense patches	450m	Reynolds et al. 68b	31.v.2006
Poaceae	Setaria parviflora (Poir.) Kerguélen	Kīpapa Trail, immediately beyond entrance, bank on S side of trail; disturbed wet *Metrosideros-Acacia-Dicranopteris* lowland forest	454m	Reynolds & Kagawa 56a	30.v.2006
Zingiberaceae	Hedychium flavescens Carey ex Roscoe	Kīpapa Gulch; along streambed	305m	Hosaka 651	10.vii.1932
Zingiberaceae	Zingiber zerumbet (L.) Sm.	Kīpapa Gulch, main streambed	305m	Hosaka 662	n.d.
Zingiberaceae	Zingiber zerumbet (L.) Sm.	Kīpapa Trail, hunter trail in drainage on N side; wet *Metrosideros-Acacia-Dicranopteris* lowland forest, *Cibotium, Psidium cattleianum, Ardisia elliptica*	413m	Reynolds & Lau 166	22.vi.2006

Family	Scientific name	Locality/Habitat/Plt description	Elev	Collector	Coll date
GYMNOSPERMS					
Araucariaceae	Araucaria columnaris (G.Forst.) Hook.f.	Kīpapa Trail, S of trail, peak E of Pu‘u Kamana; wet *Metrosideros-Acacia-Dicranopteris* lowland forest; ~5m tree, only base remains	462m	Reynolds & Elmore 112b	8.vi.2006
Araucariaceae	Araucaria columnaris (G.Forst.) Hook.f.	Kīpapa Trail, 150m from refuge boundary, N of trail; wet *Metrosideros-Acacia-Dicranopteris* lowland forest, *Psidium cattleianum;* sapling, ~1.25m; reproductively immature	451m	Reynolds et al. 75b	31.v.2006
Taxodiaceae	Cryptomeria japonica (L.f.) D.Don	O‘ahu Forest NWR, Near summit of Kīpapa drainage, below summit; grove growing in grassy field; *Axonopus fissifolius, Plantago pachyphylla;* ~15ft tree		Harbin & Wood 039	3.ix.2003
PTERIDOPHYTES					
Blechnaceae	Blechnum appendiculatum Willd.	Kīpapa stream,; wet gorge	1000ft	St. John 10017	10xi.1929
Lindsaeaceae	Lindsaea ensifolia Sw.	Kīpapa Trail, 200m from refuge boundary, base of bank on S side of trail; wet *Metrosideros-Acacia-Dicranopteris* lowland forest, *Psidium cattleianum*	438m	Reynolds et al. 77a	31.v.2006
Marattiaceae	Angiopteris evecta (G.Forst.) Hoffm.	Kīpapa Trail, ~1mi from refuge boundary, N side of trail, ~4–5m off trail; wet *Metrosideros-Acacia-Dicranopteris* lowland forest	496m	Reynolds 139	14.vi.2006
Nephrolepidaceae	Nephrolepis brownii (Desv.) Hovenkamp & Miyam.	Kīpapa Gulch; woods	1000ft	Hosaka 215	13.iv.1930
Polypodiaceae	Phlebodium aureum (L.) J.Sm.	Kīpapa Trail, 1/3mi from refuge boundary, N side of trail; on *Metrosideros polymorpha;* wet *Metrosideros-Acacia-Dicranopteris* lowland forest	464m	Reynolds & Hoffman 97a	1.vi.2006
Pteridaceae	Adiantum raddianum C.Presl	Kīpapa Gulch; in moist place	1200ft	Hosaka 1044	28.v.1933
Thelypteridaceae	Cyclosorus dentatus (Forssk.) Ching	S ridge of Kīpapa Gulch; rain forest, side of trail	1700ft	Wilson 172	23.xi.1952
Thelypteridaceae	Cyclosorus dentatus (Forssk.) Ching	Kīpapa Gulch; *Metrosideros-Antidesma* forest	1500 ft	Grant 7171	08.viii.1934
Thelypteridaceae	Cyclosorus parasiticus (L.) Farw.	Kīpapa Stream	1000ft	St. John 10013	10.xi.1929
Thelypteridaceae	Cyclosorus parasiticus (L.) Farw.	Kīpapa Stream; wet gorge	1000ft	St. John 10022	10.xi.1929

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.