Botanical Inventory of Kalauao Valley, City & County of Honolulu, Hawai‘i

Hawaii Biological Survey

Final Report

July 2006

Botanical Inventory of Kalauao Valley, City & County of Honolulu, O‘ahu

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EXECUTIVE SUMMARY

The Hawaii Biological Survey of the Bishop Museum conducted a vegetation and entomological reconnaissance of 607 hectares of Kalauao Valley, O‘ahu, mauka of ‘Aiea town and sandwiched to the north and south by Waimalu and Hālawa Valleys, respectively. The primary purposes of the survey were to document locations of rare and endangered vascular plants, provide an inventory of all vascular plants, note major resource concerns, create general plant community maps, and provide recommendations for conservation practices. Nine days of fieldwork (33 person-days for botany, 9 person-days for entomology) were conducted between November 2003 and April 2004. Results of the entomological survey will be reported elsewhere.

Bishop Museum and Kamehameha Schools, co-owners of the valley, funded the survey as members of the Ko‘olau Mountains Watershed Partnership (KMWP), a consortium of Ko‘olau watershed landowners dedicated to conducting best management practices on their watershed lands. Ownership of Kalauao Valley is split by Kalauao Stream: Bishop Museum owns 257 hectares south-southeast of the stream, while Kamehameha Schools owns 350 hectares on the north-northwest side.

For purposes of this report, the parcel was divided into upper and lower halves, roughly corresponding to a change in moisture gradient from wet to mesic. A total of 250 vascular plant taxa were noted during the survey, including 156 native taxa. Overall, 62% of all plant taxa seen were native.

The wetter upper half of Kalauao Valley is dominated by native biomass, with 76% of all vascular plants being native. The main community types are dominated by various forms of *Metrosideros polymorpha* (‘ōhi‘a), often with a ubiquitous groundcover of *Dicranopteris linearis* (uluhe). We describe six different forest or shrubland communities in this wetter zone, as well as a mixed shrub and sedgeland that mimics bog conditions, with flowering ‘ōhi‘a less than 15 cm tall, a thick layer of cryptogams, and small mounds of the native grass *Dichanthelium koolauense*.

Native species still have the upper hand at these higher elevations, with *Clidemia hirta* (Koster’s curse) the main non-native component. Most of the herbaceous and grassy weeds are concentrated along trails and disturbed hilltops. Weedy tree species are uncommon. The upland gulch habitats are much more disturbed, often with signs of severe pig damage. African tulip trees and an octopus tree were also noted in this zone, and should be removed.

The lower half of Kalauao Valley becomes progressively drier and less native, and at the lowest end is dominated by a mixture of alien weeds and forestry plantings. Natives comprise 51% of all vascular plant taxa (compared with 76% in the upper half). Still, there are extensive tracts of native forest dominated by ‘ōhi‘a and/or *Acacia koa* (koa) overstory. There is much evidence of pig damage. The gulch habitat is largely non-native. We describe six forest types in this mesic zone, three of them native-dominated.

Federally listed endangered plants seen within the survey area include *Gardenia mannii* (nā‘ū), four individuals scattered along mesic gulches and ridges; *Tetraplasandra gymnocarpa* (‘ohe‘ohe), a single individual observed on the leeward side of the summit ridge; and *Trematolobelia singularis*, a single individual observed on the summit

ridge. Candidates for Federal listing include *Cyanea lanceolata* (hāhā), a single individual observed just below the summit ridge; and *Zanthoxylum oahuense* (a'e), several trees noted below the ridgeline of 'Aiea trail. Species of Concern noted include *Labordia hosakana* (kāmakahala), scattered on cloudswept ridges and valleys and along the summit ridge; *Anoectochilus sandvicensis*, a small population found near the summit; and *Dichanthelium koolaense,* a tussock- or mat-forming grass found on wet, exposed ridgetops and slopes.

The two main threats to the native flora and fauna of Kalauao Valley are feral pig disturbance and the spread of invasive alien plant species. While biologists may prefer eradication of the feral pig, many hunters are dependent on the animal as a source of food and game. Fencing biologically significant areas from feral pig damage has proven effective in small, easily fenced sites. However, a relatively large and topographically variable area the size of Kalauao Valley would make fencing logistically difficult and financially debilitating. Thus, we recommend the establishment of active hunting teams that consistently work in the upper sections of the valley where pig activity has been observed, keeping the pig population in check in the more biologically pristine zones and important watershed areas. However, fencing might be a viable option if done on a limited scale (e.g., boglike 'Uki Mixed Shrub and Sedgeland communities, *Gardenia mannii* populations).

Many ubiquitous weeds have already established footholds in Kalauao Valley, but within the upper sections of the valley, where native plants still dominate, weedy tree species such as *Schefflera actinophylla* (octopus tree), *Cecropia obtusifolia* (cecropia), and *Spathodea campanulata* (tulip tree) are just starting to become established. The focus of eradication efforts should concentrate on such target species, whose removal can significantly retard their establishment. It is recommended that all individuals of these and other target species be removed when found above 600 m elevation in the valley.

I. INTRODUCTION

A vegetation and entomological reconnaissance of Kalauao Valley land was conducted by Bishop Museum for the Ko'olau Mountains Watershed Partnership (KMWP). Nine days of fieldwork (33 person-days for botany, 9 person-days for entomology) took place between November 2003 and April 2004. The primary purposes of the survey were to document locations of rare and endangered vascular plants, provide an inventory of all vascular plants, note major resource concerns, create general plant community maps, and provide recommendations for conservation practices.

Ia. Setting

The 607 hectare project area comprises the entire length of the ahupua'a of Kalauao, extending seaward to the Forest Reserve boundary and mauka to the crestline of the Ko'olau Mountains, sandwiched to the north and south by Waimalu and Hālawa Valleys, respectively (see Map 1, p. 20; Map 2, p. 21). Ownership in the project is split by Kalauao Stream: Bishop Museum owns 257 hectares south-southeast of the stream (TMK 9-8-01:1), while Kamehameha Schools owns 350 hectares on the north-northwest side (TMK 9-8-01:2) (see Map 2, p. 21). Rainfall ranges from 1500–4060 mm per year in the parcel, and vegetation communities in the survey area range from dry-mesic to wet. Elevation ranges from 135–840 m.

Almost all of the land in the survey area is classified as Rough Mountainous Land (rRT) by Foote et al. (1972), including all of the Bishop Museum property. 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 25–255 mm 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 1830 m elevation, with rainfall ranging from 1780 to more than 10,000 mm 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).

At the lower end of the survey area on the Kamehameha Schools property, there are sections of Rock Land (rRK) and Helemano silty clay (HLMG). Rock land has rock outcrops covering 25–90% of the ground surface, and very shallow soils. Rock lands are level to very steep, range in elevation from near sea level to over 1830 m, and have annual rainfall of 300–1500 mm. These lands are used for pasture, wildlife habitat, and water supply. Lantana, *Psidium* spp. (guava), *Melinis repens* (Natal redtop), and *Melinis minutiflora* (molasses grass) are typical alien plants in the higher-elevation examples of rock land. It can also be used for urban development, but the soil is often sticky and plastic, with high shrink-swell capacity. Thus, on steep slopes buildings are subject to sliding on saturated soils, and foundations and retaining walls to cracking.

The Helemano silty clay soil, on 30–90% slopes, is well drained and found as alluvial fans and colluvial slopes on

steep slopes in V-shaped gulches between 150 and 365 m elevation. Annual rainfall ranges from 760–1500(–1900) mm per year. These deep soils typically have a 25-cm surface layer of dark reddish brown silty clay; the subsoil is a dark reddish brown to dark red silty clay with a subangular blocky structure, and is about 13 cm thick. The surface layer is neutral, while the subsoil is neutral to slightly acid. These soils are used for pasture, woodland, and wildlife habitat. They are typically vegetated with aliens such as *Cynodon dactylon* (bermuda grass), *Schinus terebinthifolius* (Christmasberry), *Eucalyptus* spp. (eucalyptus), *Acacia confusa* (Formosa koa), *Psidium* spp. (guava), *Chamaecrista nictitans* (Japanese tea), *Syzygium cumini* (Java plum), and *Leucaena leucocephala* (koa haole).

Ib. Historical Surveys of Kalauao Valley

While no records of organized surveys of the parcel were discovered, many botanists have collected in the area during the past century. A search of the Herbarium Pacificum specimen database for Hawaiian plant vouchers at Bishop Museum pulled up a number of collections along the Kalauao-Waimalu ridge (perhaps analogous to the ridgeline on the Kamehameha Schools side of Kalauao Valley) in 1933. These included the following currently Federally endangered taxa: *Cyanea crispa* (hāhā, Campanulaceae), *Gardenia mannii* (nā‘ū, Rubiaceae), *Hesperomannia arborescens* (Asteraceae), *Labordia cyrtandrae* (kāmakahala, Loganiaceae), and *Melicope lydgatei* (‘alani, Rutaceae), as well as the rare but unprotected *Cyanea lanceolata* (hāhā, Campanulaceae), *Cyrtandra kalihii* (ha‘iwale, Gesneriaceae), and *Liparis hawaiensis* (Orchidaceae). More recently (1985), a collection of the endangered *Cyanea koolauensis* (hāhā, Campanulaceae) was made at Kalauao *(Takeuchi 2772).*

Ic. Critical Habitat Designations

In June 2003, the U.S. Fish and Wildlife Service (USFWS) published final designations of critical habitat for 101 endangered O‘ahu plant taxa (U.S. Fish and Wildlife Service 2003). The USFWS created 36 critical habitat units for O‘ahu, many of them created for multiple endangered species. Kalauao Valley is contained within Unit 20, the largest of the critical habitat units, encompassing the central and northern Ko‘olau Mountains. Designation as critical habitat does not imply that the endangered species is already present in the area; in many cases an area is designated because it provides a landbank of environmental conditions suitable for the recovery of the species, although currently unoccupied. Study of the critical habitat maps suggests that parts of the Kalauao tract are included as critical habitat for perhaps ten endangered species. The taxa and their critical habitats in the Kalauao tract are as follows:

- *Cyanea crispa* (hāhā, Campanulaceae), much of the tract designated; slopes, moist gullies, streambanks in open mesic to closed wet forest, currently unoccupied (USFWS Critical Habitat Oahu 20—*Cyanea crispa*—b)
- *Cyanea grimesiana* ssp. *grimesiana* (hāhā, Campanulaceae), much of tract below summit designated, rocky or steep streambank slopes in mesic forest often dominated by ‘ōhi‘a or koa, currently unoccupied (Oahu 20—*Cyanea grimesiana ssp. grimesiana*—a)
- *Cyanea humboldtiana* (hāhā, Campanulaceae), Ko‘olau summit ridge designated; wet ‘ōhi‘a-uluhe lowland

shrubland, currently unoccupied (Oahu 20—*Cyanea humboldtiana*—c)

- *Cyanea st.-johnii* (hāhā, Campanulaceae), Ko‘olau summit ridge designated; wet windswept slopes and ridges in ‘ōhi‘a mixed lowland shrubland or ‘ōhi‘a-uluhe lowland shrubland, currently 44 individuals along central Ko‘olau summit (Oahu 20—*Cyanea st.-johnii*—a)
- *Lobelia oahuensis* (Campanulaceae), Ko‘olau summit ridge designated, steep slopes or summit cliffs in cloudswept wet forest or lowland wet shrubland frequently exposed to heavy wind and rain, currently 13 individuals along central Ko‘olau summit (Oahu 20—*Lobelia oahuensis*—a)
- *Melicope lydgatei* (alani, Rutaceae), much of tract below summit designated, ranging from ridges in mesic to wet forests, currently 2 individuals between Wahiawā and Hālawa (Oahu 20—*Melicope lydgatei*—a)
- *Sanicula purpurea* (Apiaceae), Ko‘olau summit ridge designated, open ‘ōhi‘a mixed montane bogs or windswept shrubland in the cloud zone, currently 6 individuals between northern Ko‘olaus and Kalihi (Oahu 20—*Sanicula purpurea*—a)
- *Tetraplasandra gymnocarpa* (‘ohe‘ohe, Araliaceae), windswept summit ridges, slopes, and gullies in wet or sometimes mesic lowland forest or shrubland, in vicinity of upper Hālawa Valley; currently 28 individuals (Oahu 20—*Tetraplasandra gymnocarpa*—d)
- *Trematolobelia singularis* (Campanulaceae), Ko‘olau summit ridge between Waimano and Hālawa designated; steep, windswept cliff faces or slopes in ‘ōhi‘a-uluhe lowland wet shrubland, currently unoccupied (Oahu 20—*Trematolobelia singularis*—a)
- *Viola oahuensis* (Violaceae), Ko‘olau summit ridge from Pūpūkea to Kalihi designated, exposed, windswept ridges of moderate to steep slope in wet ‘ōhi‘a-uluhe shrubland or ‘ōhi‘a mixed montane bogs in cloud zone, currently 67 individuals (Oahu 20—*Viola oahuensis*—a)

Id. Forestry Plantings

The lower portion of the Kalauao tract, from the vicinity of the lower end of Keaiwa Heiau State Park up to Pu‘u ‘Ua‘u, contains a number of forestry plantings resulting from an active program of reforestation to revegetate lands denuded by poor land management and the depredations of browsing ungulates. This work was undertaken by the Hawaii Division of Forestry, which planted out millions of mostly non-native trees. Records show that between 1910 and 1960 (Skolmen 1980) the following species were those most frequently planted in the ‘Aiea portion of the ‘Ewa Forest Reserve: *Acacia koa* (koa, 35,000+ planted); *Grevillea robusta* (silver oak, 18,000+); *Lophostemon confertus* (Brisbane box, 13,000+); *Eucalyptus pilularis* (blackbutt eucalyptus, 5,800+); *E. calophylla* (marri eucalyptus, 5,600+); *E. camaldulensis* (river red gum, 4,000+); *E. robusta* (swamp mahogany, 4,000+); and *Casuarina glauca* (longleaf ironwood, 2,800+). Happily, the most commonly planted tree was the native koa, but there is also ample evidence of the non-native forestry plantings on the lower part of ‘Aiea Ridge, testifying to the highly disturbed nature of the vegetation in the lower forested zone behind Honolulu.

II. METHODS

The remoteness of the upper Kalauao area meant that the best strategy for that part of the survey was to be helicoptered in, with extended overnight campouts. The team did two separate 3-day, 2-night trips, with two different base camps. Map 2 (p. 21) pinpoints the base camps and survey routes. For surveying the lower half of the parcel, the ‘Aiea Loop Trail and ‘Aiea Ridge Trail were used to gain access into the valley slopes and bottom. The fieldwork strategy was to walk transects in teams of two or three while recording plant species and describing plant communities. 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. Geological features of interest were also recorded. Georeferencing was made using three Garmin GPS units and crosschecked for accuracy. Location points were all recorded in WGS 84 datum. All of the transects can be seen on Map 2 (p. 21).

Trip 1 (17–19 November 2003) Chris Puttock, Clyde Imada, Maya LeGrande, David Preston, Myra McShane. Helicopter drop at summit camp (N21.42071 W157.84641) for three-day survey (see Fig. 1, p. 18). Botanical and entomological survey around summit camp, focusing on ridges and drainages in the back of Kalauao Valley.

Trip 2 (17 December 2003) Chris Puttock, Clyde Imada, Barbara Kennedy. Walk in from ‘Aiea Loop Trail to ‘Aiea Ridge Trail. Botanical survey of mid-elevation ridges and drainage of main stream.

Trip 3 (5–7 January 2004) Chris Puttock, Clyde Imada, Maya LeGrande, Barbara Kennedy, Susan Ching-Harbin. Helicopter drop at Pu‘u Kawipo‘o campsite (N21.41675 W157.85417) for three-day survey, Botanical surveys focused around ridges and drainages to the north of Pu‘u Kawipo‘o. Entomological survey carried out on 7 January by Dan Polhemus, John Polhemus, and Barbara Kennedy near the summit region.

Trip 4 (29 January 2004) Chris Puttock, Clyde Imada, Maya LeGrande, Susan Ching-Harbin. Walk in from ‘Aiea Loop Trail to ‘Aiea Ridge Trail. Botanical survey carried out in the mid-elevation region of the valley.

Trip 5 (19 February 2004) Maya LeGrande, Clyde Imada, Barbara Kennedy. Walk in from ‘Aiea Loop Trail to Pu‘u ‘Ua‘u, dropping into main valley along ridge to WNW of the pu‘u. Botanical survey carried out in lower region of Kalauao Valley.

Trip 6 (7 April 2004) Chris Puttock, Clyde Imada, Maya LeGrande. Walk in from ‘Aiea Loop Trail to Kalauao Pool Trail. Follow trail to Kahuawai Pool and continue botanical survey up ridge on north side (Kamehameha Schools) of valley to summit or ridge trail. Continue up ridge trail and loop back down into main stream via flagged side ridge.

III. RESULTS

For purposes of this report, the 607 hectare parcel was divided into upper and lower sections, roughly corresponding to a change in moisture gradient from wet to mesic (see Map 3, p. 22). A total of 250 vascular plant taxa were noted during the survey, including 119 endemic, 37 indigenous (including "ind?"), 93 naturalized (including "nat?") and Polynesian-introduced (including "pol?"), and 1 cultivated species. Thus, 62% of all plant taxa seen were native (156 of 250).

IIIa. Upper Kalauao Survey

- 172 taxa noted (130 native, 76% of total taxa)
- 97 dicots (74 native, 76% of all dicots)
- 29 monocots (16 native, 55% of all monocots)
- 46 pteridophytes (40 native, 87% of all pteridophytes)

Upper Kalauao Valley is dominated by native biomass. The ridges rimming the upper valley are packed with small native trees and compact shrubs, including *Metrosideros rugosa* (lehua papa), *M. polymorpha* ('ōhi'a), *Melicope* spp. (alani), *Syzygium sandwicensis* ('ōhi'a hā), *Cheirodendron platyphyllum* (lapalapa), *Machaerina angustifolia* ('uki), *Coprosma longifolia* (pilo), *Broussaisia arguta* (kanawao), *Scaevola mollis* and *S. gaudichaudiana* (naupaka kuahiwi), *Dubautia laxa* (na'ena'e), *Cibotium* spp. (hāpu'u), *Sadleria* spp. (ama'u), *Hedyotis* spp. (manono), *Ilex anomala* (kāwa'u), and *Myrsine* spp. (kōlea). *Dicranopteris linearis* (uluhe) and *Freycinetia arborea* ('ie'ie) are also common. The most common aliens include *Clidemia hirta* (Koster's curse), *Pterolepis glomerata,* and *Stachytarpheta australis* (Jamaica vervain); disturbed hilltops generally were covered with the alien grasses *Axonopus fissifolius* (narrow-leaved carpetgrass), *Sacciolepis indica* (Glenwood grass), and *Paspalum conjugatum* (Hilo grass), along with 'uki and *Pterolepis*.

The upper Kalauao slopes are perhaps the richest botanically in the survey area, with 126 taxa noted, 81% of them native. One ubiquitous element of these slopes is a thick covering of uluhe. The overstory is primarily 'ōhi'a; other common smaller trees include *Antidesma platyphylla* (hame), *Psychotria* spp., *Melicope* spp., 'ōhi'a hā, *Bobea elatior* ('ahakea lau nui), *Tetraplasandra oahuensis* ('ohe mauka), and *Scaevola* spp. These slopes are relatively weed-free until the lower slopes are reached, adjacent to the stream channels. In this zone the pig damage is often severe, the vegetation much more disturbed. Some exposed side slopes we visited displayed characteristics of boggy habitats, with flowering 'ōhi'a less than 15 cm tall, a thick layer of cryptogams, and small mounds of the native grass *Dichanthelium koolauense*. Also frequently noted were groves of *Pritchardia martii* (loulu) along the slopes, often forming continuous lines of trees that were observed along many of the side ridges and spreading into adjacent drainages.

The gulches in upper Kalauao Valley are, like those of lower Kalauao, more disturbed than the ridges and slopes. The gulches here, though, have a higher native component that includes 'ōhi'a, *Pipturus albidus* (māmaki),

Boehmeria grandis ('ākōlea), and loulu palms. *Spathodea campanulata* (African tulip) trees and a *Schefflera actinophylla* (octopus tree) were also noted in this zone, and should be removed.

IIIb. Lower Kalauao Survey

- 177 taxa noted (90 native, 51% of total taxa)
- 102 dicots (51 native, 50% of all dicots)
- 37 monocots (12 native, 32% of all monocots)
- 1 gymnosperm (none native)
- 37 pteridophytes (27 native, 73% of all pteridophytes)

The lower part of 'Aiea Ridge is largely forested with native species, but there is much evidence of pig damage along the trail. At ca. 510 m elevation the ridge consists of an open canopy of 'ōhi'a, *Acacia koa* (koa), and 'ōhi'a hā, with a solid understory cover of uluhe and 'ie'ie, along with mostly native shrubs and small trees, such as *Psychotria mariniana* (kōpiko), *Wikstroemia oahuensis* ('ākia), and *Scaevola gaudichaudiana* (naupaka kuahiwi). The hiking path is lined with the invasive melastome *Pterolepis glomerata, Elephantopus mollis* (elephant's foot), and weedy grasses such as *Axonopus fissifolius*.

The slopes into Kalauao Valley at this elevation are also largely native, with 'ōhi'a/koa overstory, often a thick ground layer of uluhe, and a variety of native dry to mesic trees and shrubs, such as *Xylosma hawaiiense* (maua), *Pouteria sandwicensis* ('āla'a), *Metrosideros macropus, Rauvolfia sandwicensis* (hao), *Bobea elatior* ('ahakea lau nui), *Pittosporum glabrum* (hō'awa), 'ākia, *Cyrtandra garnotiana* (ha'iwale), *Diospyros sandwicensis* and *D. hillebrandii* (lama), and *Melicope clusiifolia* (alani). Some areas with alien plant infestations (e.g., *Clidemia, Schinus, Lantana*) were seen but were not extensive.

The gulch habitat has the most disturbed habitat on this transect. The overstory consists of *Psidium guajava* (common guava) and *Aleurites moluccana* (kukui). The groundcover is mostly *Oplismenus hirtellus* (basketgrass), with *Clidemia, Blechnum appendiculatum, Rubus rosifolius* (thimbleberry), and ginger (*Hedychium* sp.) plants. 'Ōhi'a, *Hibiscus arnottianus* (koki'o ke'oke'o), *Pipturus albidus* (māmaki), and *Christella cyatheoides* (kikawaiō) are common natives along the streambanks.

IIIc. Vegetation Zones

The vegetation zones of Kalauao Valley vary according to elevation and climate, and in some cases geological features dictate the plant communities of the area. Seven vegetation types were observed in the 'upper' Kalauao survey area, dominated by variations of Lowland Wet communities, and seven are described for the 'lower' part of Kalauao Valley, those being Lowland Mesic Forest communities. They are described here, along with specific species associated with each type. The vegetation classification system of Gagné and Cuddihy (1999) was adopted for this section.

Lowland Wet Forests

'Ōhi'a/Uluhe Fern Forest: Many of the main ridges and side rides in the mid-elevation sections of Kalauao 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), *Hedyotis* spp. (manono), *Myrsine* spp. (kōlea), *Syzygium sandwicensis* ('ōhi'a hā), *Bobea elatior* ('ahakea lau nui), *Ilex anomala* (kawa'u), and rarely *Gardenia mannii* (nā'ū). The tangled masses of uluhe can be difficult to move through, especially in steep and uneven terrain. Often pig trails can be found tunneled underneath the thick mats of fern and are not apparent at first glance because the upper levels of the fern mat are not disturbed. Sometimes these tunnels are referred to as "pig highways" because the pigs utilize these tunnels to get from one area to another, but rarely use the areas for rooting or bedding down. Thus, evidence of pig damage, other than the tunnels, is usually minimal in this plant community. Some alien plant species noted in this community were *Arundina graminifolia* (bamboo orchid), *Pluchea carolinensis* (sourbush), *Clidemia hirta* (Koster's curse), and *Rubus rosifolius* (thimbleberry).

'Ōhi'a Lowland Wet Forest: The main valley of Kalauao is dissected by alternating side ridges and gulches that lead down to the main stream. The vegetation at the top of these ridges in the upper elevations of the valley tend to be more windswept, with a dominant groundcover of ferns 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 'ahakea lau nui, *Elaeocarpus bifidus* (kalia), *Hedyotis terminalis* (manono), *Pittosporum glabrum* (hō'awa), 'ōhi'a hā, *Psychotria* spp. (kōpiko), *Diospyros sandwicensis* (lama), and *Melicope* spp. (alani). The understory is comprised of few shrubs, including *Wikstroemia oahuensis* ('ākia), *Dodonaea viscosa* ('a'ali'i), *Broussaisia arguta* (kanawao), *Pipturus albidus* (māmaki), *Touchardia latifolia* (olonā), *Charpentiera ovata* (pāpala), and Koster's curse. 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), *Alyxia oliviformis* (maile), and *Cocculus orbiculatus* (huehue). Pig trails are quite common contouring the slope faces and leading into the drainages. *Psidium guajava* (common guava) appears increasingly dominant as the pig disturbance helps to spread the seeds and open up areas to bare soil, where weedy plants can quickly invade and proliferate.

'Ōhi'a/'Ōlapa Forest: The headwaters of Kalauao Valley originate at the summit ridge that divides the windward and leeward range of the Ko'olau mountain. There is a false summit to the west of the true summit, creating a gulch that runs north-south at the very back of the valley. This area catches 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), *Hedyotis* spp. (manono), *Dubautia* spp. (na'ena'e), *Ilex anomala* (kāwa'u), *Pipturus albidus* (māmaki), *Platydesma spathulata* (pilo kea), *Scaevola mollis* (naupaka kuahiwi), and *Cibotium* spp. (hāpu'u). A few of the alien species that were observed in this

zone were *Cecropia obtusifolia* (trumpet tree) and Koster's curse. The *Clidemia* forms a small monotypic stands on the slopes near the back of the drainage. A population of one of Hawaii's rare orchids, *Anoectochilus sandvicensis* (jewel orchid) was found scattered within the understory of the weedy slope in a 3 m square area.

Loulu Lowland Forest: As described under Māmaki Riparian Shrubland, the native loulu fan palm *(Pritchardia martii)* could be seen forming distinctive lines of trees on steep open slopes and in wet drainages ranging from near the wet summit region down to elevations near Pu'u Kawipo'o. In these groves there are few understory components. Other than a few scattered *Broussaisia arguta* (kanawao) and alien grass species, the ground beneath the loulu palms is quite depauperate. These groves are most often associated with Māmaki Riparian Shrubland and 'Ōhi'a Lowland Wet Forest.

Alien Wet Forest: Disturbance along the banks of the main stream in the upper valley due to early Hawaiian cultivation and habitation has opened up areas for weedy species to become established. Dominant trees along the stream banks are *Aleurites moluccana* (kukui), *Psidium guajava* (common guava), *Syzygium cumini* (Java plum), and *Syzygium malaccense* (mountain apple). Native tree species that can still be found scattered in the forest are *Hibiscus arnottianus* ssp. *arnottianus* (koki'o ke'oke'o), *Metrosideros polymorpha* ('ōhi'a lehua), and *Pisonia umbellifera* (pāpala kēpau), along with shrubs like *Pipturus albidus* (māmaki) and *Touchardia latifolia* (olonā). This region along the main stream is the most impacted by pigs. Trails and wallows with standing water were observed continuously along the stream banks. Hawaiian *Cyrtandra* (ha'iwale) species are extremely vulnerable to pig disturbance and were conspicuously lacking from this habitat.

Lowland Wet Shrublands

'Ōhi'a Lowland Wet Shrubland: This plant community is restricted to the main summit ridge of Kalauao Valley (Fig. 3, p. 18). The windswept ridge is dominated by groundcover consisting mainly of uluhe interspersed with *Vaccinium* sp. ('ōhelo), *Machaerina angustifolia* ('uki), *Plantago pachyphylla* (laukahi kuahiwi), *Nertera granadensis* (mākole), *Clidemia hirta* (Koster's curse), and *Schizaea robusta* ('ōali'i makali'i). In this zone, one individual of the endangered *Trematolobelia singularis* was observed with a dry inflorescence. Around the base of the electrical tower located on the summit ridge, the vegetation consists mainly of weedy species due to the disturbance caused by clearing and leveling the area for the tower. The vegetation found around the tower consists mainly of alien grasses *Axonopus fissifolius* (narrow-leaved carpetgrass), *Sacciolepis indica* (Glenwood grass), and *Paspalum conjugatum* (Hilo grass). *Cordyline fruticosa* (ti), *Stachytarpheta* sp. (oī), *Rubus rosifolius* (thimbleberry), *Centella asiatica* (Asiatic pennywort), *Ageratina adenophora* (Maui pāmakani), and *A. riparia* (Hāmākua pāmakani) are prevalent in the disturbed areas. On the leeward side of the summit, just below the ridgeline where plants are slightly more protected from the strong winds, stunted tree species of *Metrosideros rugosa* (lehua papa), *Hedyotis* spp. (manono), *Tetraplasandra* sp. ('ohe mauka), *Cheirodendron platyphyllum* (lapalapa), *Ilex anomala*

(kāwa'u), *Scaevola* spp. (naupaka kuahiwi), and *Myrsine* spp. (kōlea) can be seen. Dominant shrubs include *Wikstroemia oahuensis* ('ākia), *Dubautia laxa* (na'ena'e pua melemele), *Coprosma longifolia* (pilo), and *Broussaisia arguta* (kanawao). One individual of *Cyanea lanceolata* (hāhā), a rare lobelioid, was noted in this area along with one *Tetraplasandra gymnocarpa* ('ohe'ohe, Araliaceae), a Federally listed endangered species.

Māmaki Riparian Shrubland: This vegetation type can be found in the upper (above 600 m elevation) side drainages of Kalauao on the southern side (Bishop Museum) of the valley. The wet, deep drainages contain *Pritchardia martii* (loulu) trees in populations that start at the top of a ridge and run continuously down into the bottom of the gulch. The palm forest was utilized to access the gulch by hanging webbing line from one palm trunk and dropping to the next one down. At the bottom of the gulch on either side of the intermittent stream, the vegetation was characterized by *Pipturus albidus* (māmaki), *Touchardia latifolia* (olonā), *Metrosideros tremuloides* (lehua 'āhihi), *M. macropus* ('ōhi'a lehua), *Broussaisia arguta* (kanawao), *Deparia prolifera, Rhynchospora sclerioides* (kuolohia) *Clermontia* sp. ('ōhā wai), *Cyanea* sp. (hāhā, rare), and two species of *Cyrtandra* (ha'iwale). One was identified as *C. lessoniana* and the other species is undetermined. The weedy components of the area include *Clidemia hirta* (Koster's curse), *Erigeron karvinskianus* (daisy fleabane), and *Cecropia obtusifolia (*trumpet tree).

Lowland Wet Mixed Communities

'Uki Mixed Shrub and Sedgeland: A set of wide flat ridges at around 725 m elevation off of the main 'Aiea ridge trail have a "bog-like" vegetation type (Fig. 4, p. 18). The wide, gently sloping ridges are windswept and subject to heavy cloud cover and rain. The substrate is hard rocky shale covered with a thick mossy layer interspersed with dwarfed vegetation. Native components include *Dichanthelium koolauense* (Fig. 5, p. 18), *Metrosideros polymorpha, Scaevola* spp., *Sadleria pallida* ('ama'u 'i'i), *Bidens macrocarpa* (ko'oko'olau) *Sphenomeris chinensis (*pala'ā), *Chamaesyce clusiifolia* ('akoko), *Rhynchospora* sp., and *Dicranopteris linearis* (uluhe). The few invasives mixed in with the mass of tangled plants are *Sacciolepis indica, Axonopus fissifolius, Pterolepis glomerata,* and *Rubus rosifolius. Machaerina angustifolia* ('uki) plants can be found at the edges of the sedgeland. The area is similar to the description of the Castle bog located in the Ko'olau mountains north of Kalauao described by Samuel Gon III in 1994 (Gon 1994).

Lowland Mesic Forests

'Ōhi'a Lowland Mesic Forest: Extensive areas of native mesic forest in Kalauao are dominated by various forms of *Metrosideros polymorpha,* especially along ridgelines and upper slopes, but also extending down to gulch bottoms (Fig. 6, p. 18). Often on upper slopes the 'ōhi'a forms an open canopy with an understory dominated by uluhe. In more closed-canopy examples, associated native trees and shrubs include koa, *Psychotria mariniana* (kōpiko), *Santalum freycinetianum* ('iliahi), *Wikstroemia oahuensis* ('ākia), and *Scaevola gaudichaudiana* (naupaka kuahiwi), *Cibotium* (hāpu'u) tree ferns, and the

vining *Freycinetia arborea* (‘ie‘ie). Weeds were not noted in alarming numbers; these included lantana, *Pterolepis glomerata,* and the grasses *Andropogon virginicus* (broomsedge), *Setaria palmifolia* (palmgrass), *Axonopus fissifolius,* and *Paspalum conjugatum* (Hilo grass). This zone is bordered upslope by ‘Ōhi‘a Lowland Wet Forest and downslope by Koa Mesic Forest or Lama/‘Ōhi‘a Lowland Forest.

Koa Mesic Forest: Grading into moister forests dominated by *Metrosideros polymorpha* (‘ōhi‘a lehua), this forest type is often characterized by large old trees of *Acacia koa* (koa) on open ridges and upper sideslopes, generally surrounded by a blanket of *Dicranopteris linearis* (uluhe) fern groundcover (Fig. 7, p. 19). Many of the associated species are shared with the ‘Ōhi‘a Lowland Mesic Forest type. In its best development the subcanopy includes the natives ‘ōhi‘a *, Santalum freycinetianum* (‘iliahi), *Xylosma hawaiiense* (maua), *Pouteria sandwicensis* (‘āla‘a), *Psydrax odorata* (alahe‘e), *Pittosporum glabrum* (ho‘awa), *Rauvolfia sandwicensis* (hao), *Syzygium sandwicensis* (‘ōhi‘a hā), *Bobea elatior* (‘ahakea lau nui), *Wikstroemia oahuensis* (‘ākia), and *Dodonaea viscosa* (‘a‘ali‘i), as well as *Freycinetia arborea* (‘ie‘ie), *Cibotium* spp. (hāpu‘u), and *Alyxia oliviformis* (maile). Weeds include strawberry guava, *Clidemia hirta* (Koster’s curse), *Schinus terebinthifolius* (Christmasberry), *Ageratina riparia* (Hāmākua pāmakani), and the weedy grasses found in ‘Ōhi‘a Lowland Mesic Forest. This zone is bordered downslope by Guava or Kukui Forest

Lama/‘Ōhi‘a Lowland Forest: On steep mesic slopes there is an association where a forest of *Diospyros sandwicensis* (lama; sometimes along with *D. hillebrandii*) is codominant with *Metrosideros polymorpha* (‘ōhi‘a lehua). In its best development the canopy is interlocking and associated natives include *Rauvolfia sandwicensis* (hao), *Nestegis sandwicensis* (olopua), *Pleomele halapepe* (halapepe), *Santalum freycinetianum* (‘iliahi), *Psydrax odorata* (alahe‘e), *Pittosporum glabrum* (ho‘awa), *Xylosma hawaiiense* (maua), *Alyxia oliviformis* (maile), and *Carex wahuensis*. The soils are generally granular and quite deep. Weeds include common guava and strawberry guava, *Schefflera actinophylla* (octopus tree), *Clidemia hirta* (Koster’s curse), *Ageratina riparia* (Hamakua pamakani), and *Oplismenus hirtellus* (basketgrass). This zone is bordered downslope by Guava or Kukui Forest, above by ‘Ōhi‘a Lowland Mesic Forest or Koa Mesic Forest.

Kukui Forest: Forests of *Aleurites moluccana* (kukui) dominate some of the valley bottom and side drainages in the lower part of Kalauao Valley, made obvious by their distinctive silvery green foliage. A Polynesian introduction, kukui may be current inhabitants of sites formerly cultivated by ancient Hawaiians for wetland kalo *(Colocasia esculenta)* and long since abandoned. This alien-dominated forest often consists of 9–12 m tall kukui forming an open to closed canopy on the banks of boulder-strewn streams. Alien trees typically associated with kukui include *Syzygium malaccense* (mountain apple) and *Psidium guajava* (common guava). Monstrous trees of *Ficus microcarpa* (Chinese banyan) dot the valley bottom and lower slopes. Fairly common native elements include the trees *Hibiscus arnottianus* (koki‘o ke‘oke‘o), *Pisonia umbellifera* (papala kepau), and *Metrosideros polymorpha* (ohia lehua), and the climbing *Freycinetia arborea* (‘ie‘ie). *Oplismenus hirtellus* (basketgrass), *Paspalum conjugatum* (Hilo grass), and

Setaria palmifolia (palmgrass) are common understory grasses; the ferns include *Blechnum appendiculatum* and *Christella* spp., and the native tree fern *Cibotium chamissoi* (hapu'u). *Cordyline fruticosa* (ti), *Zingiber zerumbet* (shampoo ginger), and *Dioscorea bulbifera* (bitter yam) are common understory plants. This zone is highly disturbed by wild pigs.

Guava Forest: Alien forests of *Psidium cattleianum* (strawberry guava) and *P. guajava* (common guava) are common in much of the lower half of Kalauao Valley. At its best development, strawberry guava forms monodominant thickets on ridges and upper slopes, creating a dense canopy best suited for the germination of more strawberry guava seedlings. Remnant native elements may include *Acacia koa* (koa), *Metrosideros polymorpha* ('ōhi'a lehua), and *Psydrax odorata* (alahe'e), indicating that 'Ōhi'a Lowland Mesic Forest or Koa Mesic Forest may have been usurped by the guava. Common guava becomes more abundant lower on gulch slopes, usually in association with other alien trees and shrubs. Guava Forest grades into Kukui Forest near the gulch bottoms. Various other aliens can become locally dominant in the disturbed lower elevation forests, including *Schinus terebinthifolius* (Christmasberry) and *Ardisia elliptica* (shoebutton ardisia).

Bamboo Forest: Alien thickets of the green-stemmed running bamboo *Phyllostachys nigra* (black bamboo) form expanding monodominant stands on lower ridges and slopes on both the Bishop Museum and Kamehameha Schools property. These thickets are usurping 'Ōhi'a Lowland Mesic Forest or Koa Mesic Forest. One healthy clump of the Polynesian-introduced bamboo *Schizostachyum glaucifolium* ('ohe) was noted above the streambank on the Bishop Museum side above the Kalauao Pool, growing in Kukui Forest (Fig. 11, p. 19).

IIId. Noteworthy Biological Discoveries/Taxa of Conservation Significance

- *Gardenia mannii* (Endangered) [Nā'ū]—A tree up to 15 m tall in the Rubiaceae, produces fragrant white flowers and orange fruit at maturity (Fig. 8, p. 19). Four individual adult trees were found within Kalauao Valley. They are scattered on side gulches and ridges between 455 and 520 m elevation. Significantly, none of these individuals are currently located in any of the USFWS-designated critical habitat polygons, the closest site being a 206 hectare parcel to the north in the Waikakalaua and Kīpapa drainages. Most trees appeared to be in early bud (January 2004). The trees are growing out of patches of uluhe with *Metrosideros polymorpha, Bobea elatior, Antidesma platyphyllum* (hame), and *Perrottetia sandwicensis* ('olomea). Threats include pigs and replacement by weedy plant species.
- *Tetraplasandra gymnocarpa* (Endangered) ['Ohe'ohe]—A tree up to 10 m tall with odd-pinnate leaves. The species is distinguished by its reduced hypanthium, resulting in the ovary appearing fully superior. Trees are usually observed on the windward side of the windswept Ko'olau summit, but occasionally individuals are observed on the leeward side. One individual was observed on the leeward side of the summit ridge within the boundaries of Kalauao Valley.
- *Trematolobelia singularis* (Endangered)—A rare Hawaiian lobelioid distinguished by its unbranched inflorescence. One individual with an old inflorescence was observed on the summit ridge.

- *Cyanea lanceolata* (Candidate) [Hāhā]—Unbranched lobelioid with stiff leaves and purple flowers. One individual was observed just below the summit ridge on the leeward side in a protected pocket of mixed natives. Only one flower was observed; that and a leaf were collected for voucher and identification.
- *Zanthoxylum oahuense* (Candidate) [A'e]—Monoecious, branched trees up to 6 m tall with fragrant trifoliate leaves. Several trees were noted below the ridgeline of 'Aiea trail within Kalauao Valley (Fig. 9, p. 19).
- *Labordia hosakana* (Species of concern) [Kāmakahala]—Low-growing branched shrubs with dark green leaves and yellowish orange flowers. Scattered on cloudswept ridges and valleys in the uppermost Kalauao Valley and summit ridge.
- *Anoectochilus sandvicensis* (Species of concern)—Perennial herb with sheathing leaves and erect inflorescences. One small population was found in the understory of *Clidemia hirta* in the headwaters of Kalauao. Threats include disturbance by feral pigs and competition from alien plant species.
- *Dichanthelium koolaense* (Species of concern)—Perennial tussock- or mat-forming grass found on wet, exposed ridgetops and slopes in the central Ko'olaus. Noted occasionally in the 'Uki Mixed Shrub and Sedgeland habitats (Fig. 5, p. 18).

IIIe. Major Resource Concerns

- *Ardisia crenata* (Hilo holly)—This small erect shrub is an escape from cultivation, and is readily transported by birds attracted to its round, dark red, fleshy, pea-sized fruit. A few plants found near the wet summit area were destroyed.
- *Ardisia elliptica* (shoebutton ardisia)—This small, shade-tolerant tree becomes more common on the valley floor and lower gulch slopes at the lower end of the parcel. It can form monotypic stands in disturbed wet lowland areas. It is bird-dispersed by its attractive red to black fruit.
- *Cecropia obtusifolia* (trumpet tree)—This gangly, rapidly growing but short-lived tree has large, many-lobed, scabrous leaves silvery on the undersurface that can form a dense canopy, impeding growth of understory plants. The seeds are bird-dispersed. Usually seen in disturbed mesic forest, a few saplings were noted in wet forest below the summit area.
- *Clidemia hirta* (Koster's curse)—This noxious, shade-tolerant melastome shrub with purple, bird-dispersed fruit, is rampant throughout the moister parts of the Ko'olaus, and is quite established on some of the ridge slopes, where it forms monotypic stands.
- *Ficus microcarpa* (Chinese banyan)—Numerous large, spreading trees dot the lower part of the valley, their fruit spread by birds. The dense canopy excludes most understory growth. Chinese banyan prefers mesic, disturbed habitats and was not seen in the wetter native upland zone.
- *Heliocarpus popayanensis* (white moho)—This fast-growing forestry tree with usually 3-lobed leaves is spread by its wind-dispersed, plumose-bristly fruit and appears to be expanding its geographic range in wet valleys. The single sapling noted was destroyed.

- *Melaleuca quinquenervia* (paperbark)—A single tall tree of this well-known reforestation planting and invasive species was noted on an open side ridge near the summit area; it should be removed. Paperbark has wind-dispersed seeds and the fallen leaves have allelopathic effects.
- *Paederia foetida* (maile pilau)—This aggressive stinky vine can smother anything in its path in its preferred mesic habitats. The fruit is bird-dispersed.
- *Passiflora suberosa* (huehue haole)—This passionfruit vine with ropy stems can smother shrubs and trees. It prefers the lower, drier elevations of the parcel. The fruit is bird-dispersed.
- *Phyllostachys nigra* (black bamboo)—Several expanding patches of this running bamboo were noted on the lower valley slopes, where it forms impenetrable monotypic thickets.
- *Psidium cattleianum* (strawberry guava)—*Psidium cattleianum* is uncommon in the upper native zone but quite common in the lower part of the survey area, sometimes forming monotypic stands. Both the red-fruited and the taller yellow-fruited form are present. Strawberry guava is one of the most intractable of mesic and wet forest noxious pests.
- *Psidium guajava* (common guava)—This widespread weedy tree is fairly common in the disturbed upper valley gulches, aided in distribution by pigs and birds, and quite common in the lower valley floor.
- *Schefflera actinophylla* (octopus tree)—This highly invasive, popularly cultivated tree has large, palmately compound leaves and distinctive inflorescences of radiating arms pinkish red throughout. Octopus tree is fast-growing, shade-tolerant, and readily distributed by fruit-eating birds. It can invade undisturbed native forests and is often found growing epiphytically on native trees. Infrequently noted in the upper wet forest, it becomes more common in the lower, more disturbed part of the parcel.
- *Schinus terebinthifolius* (Christmasberry)—A ubiquitous spreading noxious weed tree of mesic slopes; not a problem in the wetter upland zone. The bright red fruit are bird-dispersed.
- *Spathodea campanulata* (African tulip)—This invasive tree with large, bright orange-red, bell-shaped flowers is a popular cultivated plant, but readily dispersed and naturalized in moist to wet forests by its flat, winged fruit. It has the ability to invade undisturbed native forests.
- *Trema orientalis* (gunpowder tree)—A large, open-crowned tree common on disturbed mesic slopes and valley floors. The fruit is bird-dispersed.

IV. RECOMMENDATIONS

The two main threats to the native flora and fauna of Kalauao Valley at this time are feral pig disturbance and the spread of invasive alien plant species. The feral pig *(Sus scrofa)* has had a negative effect on the native Hawaiian forest since its establishment as a wild ungulate in the islands (Fig. 10, p. 19). A cross between the Polynesian pig and the European pig, it has adapted to the wetter forests of the islands and proven to be detrimental to native plant taxa while helping to facilitate the spread of introduced plant species.

The feral pig has proved difficult to control. Biologists would like to see the eradication of the introduced animal, but many hunters have become dependent on the animal as a source of food and game. Compromising on the management of this animal, along with all other feral ungulates in Hawai'i, has been complicated, to say the least.

Fencing biologically significant areas has proven effective where the area is small enough and funding is available for continual upkeep. A relatively large and topographically variable area the size of Kalauao Valley, on the other hand, makes fencing logistically difficult and financially debilitating. Also, adjacent areas in the Ko‘olau Range are equally deserving of protection from feral pigs, or in some cases moreso. Therefore, the recommended management for feral pigs in Kalauao Valley would be to establish active hunting teams that consistently work in the upper sections of the valley where pig activity has been observed, keeping the pig population from becoming larger and more established in the more biologically pristine zones and important watershed areas. However, fencing might be a viable option if done on a limited scale (e.g., boglike ‘Uki Mixed Shrub and Sedgeland communities, *Gardenia mannii* populations).

The establishment and spread of alien plant species is a major concern for the native components of the valley. Many of the areas already have monotypic stands of invasive plant species, but within the upper sections of the valley, where native plants dominate, several invasive plant species are just becoming established. The focus of eradication should be on these species where headway can be made in checking their spread. In terms of Kalauao Valley, those species include *Schefflera actinophylla* (octopus tree), *Cecropia obtusifolia* (cecropia), and *Spathodea campanulata* (African tulip). It is recommended that all individuals of these three taxa be removed when found above 2000 feet elevation in Kalauao Valley.

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Figure 1. Campsite 1 near the summit.

Figure 2. Ko'olau summit area looking north.

Figure 3. 'Ōhi'a Lowland Wet Shrubland along the Ko'olau summit.

Figure 4. 'Uki Mixed Shrub and Sedgeland, including diminutive flowering 'ōhi'a.

Figure 5. *Dichanthelium koolauense* is a tussock-forming grass found on open wet ridges.

Figure 6. An example of 'Ōhi'a Lowland Mesic Forest

Figure 7. Koa Mesic Forest is dominated by large koa trees.

Figure 8. *Gardenia mannii,* endangered member of the coffee family (Rubiaceae).

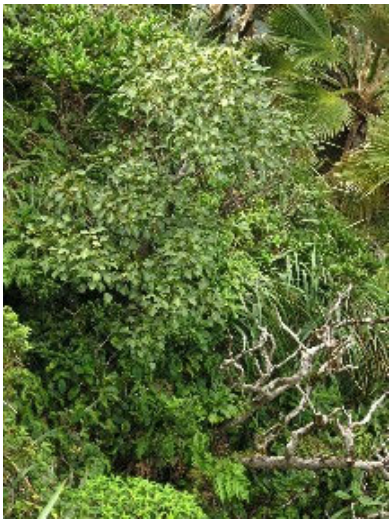

Figure 9. *Zanthoxylum oahuense,* a rare endemic citrus relative.

Figure 10. There was ample evidence of pig damage, such as eaten hāpu'u trunks.

Figure 11. A small patch of *Schizostachyum glaucifolium,* the Hawaiian bamboo, was noted.

Figure 12. Lower-elevation gulches were very weedy, such as this one dominated by common guava.


DeLORME
Topo USA 5.0
Map 1: Location of Kalauao Valley
Hawaiian Islands
Natl Wildlife Refuge
Kahuku
Laie
Hauula
Haleiwa
Waialua
Kaaawa
93
Maili
Kalauao Valley
80
Makaha
Waianae
Puu
Kaua
Mililani
Honolulu Forest
Reserve
Kaneohe
630
Nanakuli
Waipahu
Pearl City
83
Aiea
63
Waimanalo
Kapolei
KH
76
Honolulu
95
Mamala
Bay
72
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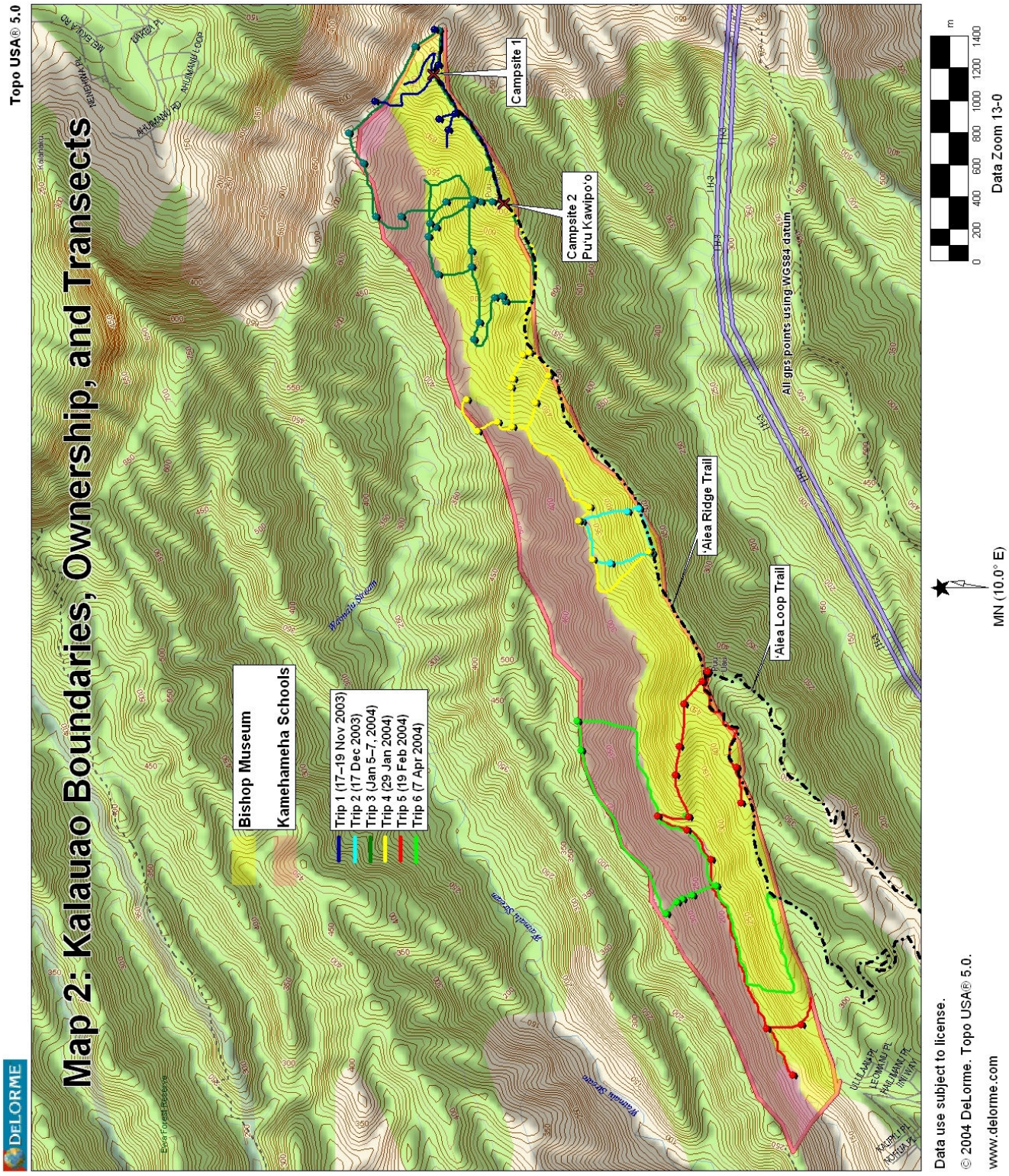
MN (10.0° E)
km
0 3 6 9 12 15 18
Data Zoom 8-0


Map 2: Kalauao Boundaries, Ownership, and Transects
Topo USA® 5.0
DeLORME
Bishop Museum
Kamehameha Schools
Trip 1 (17–19 Nov 2003)
Trip 2 (17 Dec 2003)
Trip 3 (Jan 5–7, 2004)
Trip 4 (29 Jan 2004)
Trip 5 (19 Feb 2004)
Trip 6 (7 Apr 2004)
Campsite 1
Campsite 2
Pu'u Kawipo'o
'Alea Ridge Trail
'Alea Loop Trail
All gps points using WGS84 datum
Data Zoom 13-0
MN (10.0° E)
Data use subject to license.
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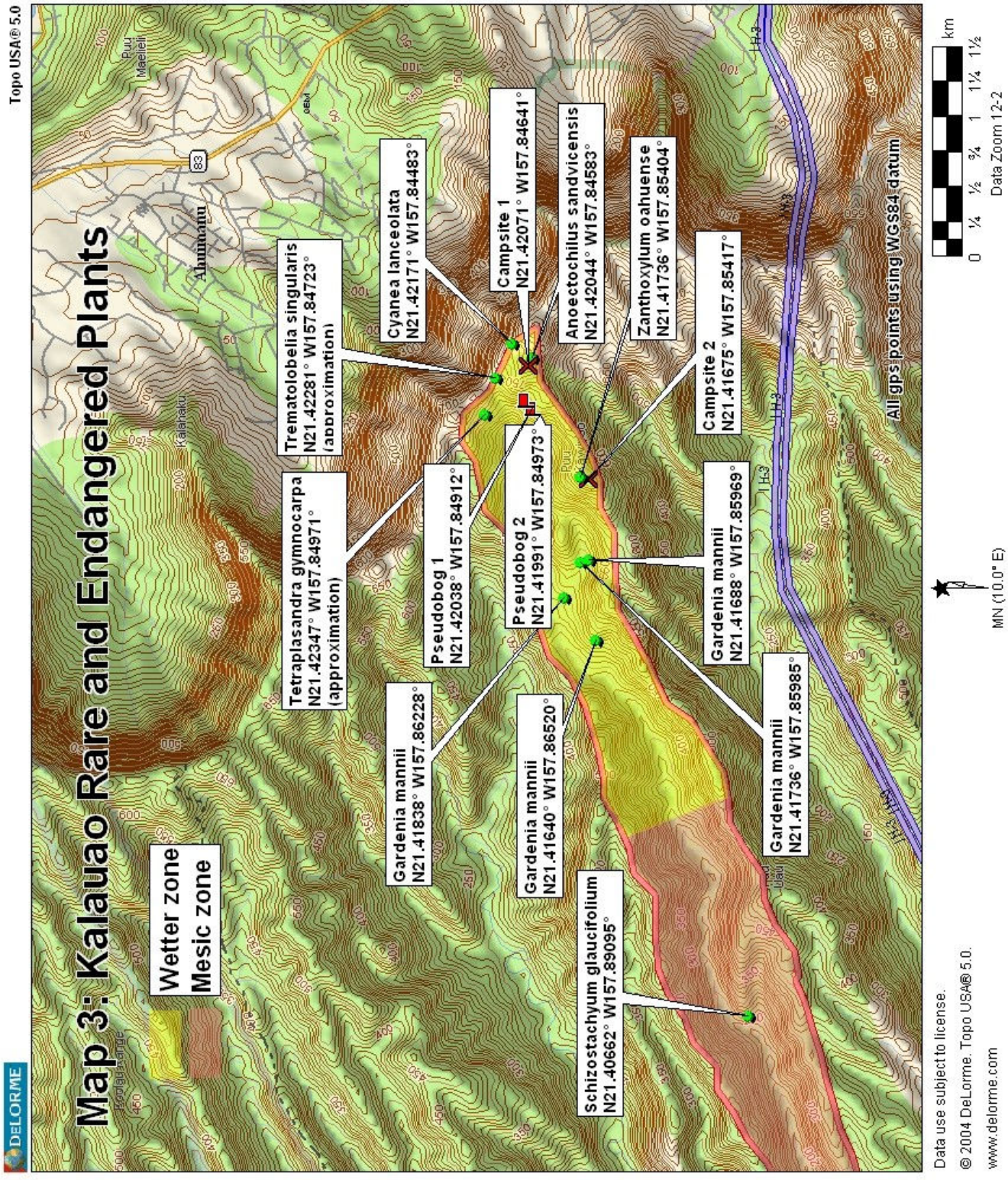
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Map 3: Kalauao Rare and Endangered Plants
Wetter zone
Mesic zone
Tetraplasandra gymnocarpa N21.42347° W157.84971° (approximation)
Trematolobelia singularis N21.42281° W157.84723° (approximation)
Cyanea lanceolata N21.42171° W157.84483°
Campsite 1 N21.42071° W157.84641°
Anoectochilus sandvicensis N21.42044° W157.84583°
Zanthoxylum oahuense N21.41736° W157.85404°
Campsite 2 N21.41675° W157.85417°
Gardenia mannii N21.41688° W157.85969°
Gardenia mannii N21.41736° W157.85985°
Pseudobog 1 N21.42038° W157.84912°
Pseudobog 2 N21.41991° W157.84973°
Gardenia mannii N21.41838° W157.86228°
Gardenia mannii N21.41640° W157.86520°
Schizostachyum glaucifolium N21.40662° W157.89095°
All gps points using WGS84 datum
MN (10.0° E)
km
0 ¼ ½ ¾ 1 1¼ 1½
Data Zoom 12-2
Data use subject to license.
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APPENDIX: Kalauao Valley Plant Checklist

The following is a list of vascular plant species noted during walk-through surveys of 607 hectares of Kalauao Valley land between 17 November 2003 and 7 April 2004. A total of 250 taxa were noted during the survey, including 119 endemic, 37 indigenous (including "ind?"), 93 naturalized (including "nat?") and Polynesian-introduced (including "pol?"), and 1 cultivated plant.

Plants are divided into three main groups: dicots, monocots, gymnosperms, and pteridophytes. Within these groups, plants are arranged alphabetically by family, genus, and species. Each entry includes scientific name with author citation, biogeographic status, common name (if available), Hawaii State noxious weed status (Hawaii Department of Agriculture), Federal endangerment status (if any), and presence or absence in each of six general topographical zones (upper/lower Kalauao ridge, slope, or valley). Taxonomy, status, and common names are in accordance with Wagner et al. (1999a), Palmer (2003), or Staples and Herbst (2005). A number of specimens were collected and deposited in the Bishop Museum *Herbarium Pacificum*; some unknown species were collected and compared with herbarium collections to secure correct identifications. An explanation of abbreviations used in the list follows.

Biogeographic Status (from Wagner et al. 1999a)

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

nat? Questionably/probably naturalized: possibly indigenous

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

cult Cultivated

Federal Endangerment Status

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 (ESA)

C Candidate: species for which there is sufficient information on biological status and threats to propose them as Endangered or Threatened, but not yet protected under ESA

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

Noxious Weed Status

An asterisk (*) preceding the scientific name indicates that the species is a noxious weed designated for eradication or control by the Hawaii 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. Seven noxious weed species are included in the following checklist: *Ageratina adenophora, Ageratina adenophora, A. riparia, Elephantopus mollis, Clidemia hirta var. hirta, Ardisia elliptica,* and *Andropogon virginicus*.

lr = Lower ridge, ls = Lower slope, lv = Lower valley, ur = Upper ridge, us = Upper slope, uv = Upper valley

SCIENTIFIC NAME	STATUS	COMMON NAME	FEDST	VALLEY LOCALITY
DICOTS				
Amaranthaceae				
Charpentiera ovata Gaudich. var. ovata	end	pāpala		ls
Anacardiaceae				
Mangifera indica L.	nat	mango		lr, ls, lv
Schinus terebinthifolius Raddi	nat	Christmas berry		lr, ls, lv
Apiaceae				
Centella asiatica (L.) Urb.	nat	Asiatic pennywort		lr, us
Apocynaceae				
Alyxia oliviformis Gaudich.	end	maile		lr, ls, ur, us, uv
Rauvolfia sandwicensis A. DC.	end	hao		ls, us
Aquifoliaceae				
Ilex anomala Hook. & Arn.	ind	kāwa'u		ls, ur, us
Araliaceae				
Cheirodendron platyphyllum (Hook. & Arn.) Seem. ssp. platyphyllum	end	'ōlapa, lapalapa		ur, us
Cheirodendron trigynum (Gaudich.) A. Heller ssp. trigynum	end	'ōlapa, lapalapa		ls, ur, us
Schefflera actinophylla (Endl.) Harms	nat	octopus tree, umbrella tree		lr, ls, lv, uv
Tetraplasandra gymnocarpa (Hillebr.) Sherff	end	'ohe'ohe	E	us
Tetraplasandra oahuensis (A.Gray) Harms	end	'ohe mauka		ls, ur, us
Asclepiadaceae				
Hoya sp.	nat			lv
Asteraceae				
*Ageratina adenophora (Spreng.) R.M. King & H. Rob.	nat	Maui pāmakani		ur, uv
*Ageratina riparia (Regel) R.M. King & H. Rob.	nat	Hāmākua pāmakani		ls , lv, uv
Ageratum conyzoides L.	nat	maile hohono		lr, ur
Bidens macrocarpa (A. Gray) Sherff	end	ko'oko'olau		ls, ur, us
Conyza bonariensis (L.) Cronquist	nat	hairy horseweed		us
Dubautia laxa Hook. & Arn. ssp. laxa	end	na'ena'e pua melemele		ur, us
Dubautia plantaginea Gaudich. ssp. plantaginea	end	na'ena'e		us
*Elephantopus mollis Kunth	nat	elephant's-foot		lr

Emilia fosbergii Nicolson	nat	pualele		lr
Emilia sonchifolia (L.) DC. var. javanica (Burm. f.) Mattf.	nat	Flora's paintbrush		lr, ls
Erechtites valerianifolia (Wolf) DC.	nat	fireweed		ls, us, uv
Erigeron karvinskianus DC.	nat	daisy fleabane		us, uv
Pluchea carolinensis (Jacq.) G. Don	nat	sourbush, marsh fleabane		ls, lv, uv
Sphagneticola trilobata (L.) Pruski	nat	wedelia		ls
Youngia japonica (L.) DC.	nat	Oriental hawksbeard		lv, us
Bignoniaceae				
Spathodea campanulata P. Beauv.	nat	African tulip tree		uv
Buddleiaceae				
Buddleia asiatica Lour.	nat	huelo ʻīlio, dog tail		ls, uv
Campanulaceae				
Clermontia sp.	end	ʻōhā wai		uv
Cyanea lanceolata (Gaudich.) Lammers, Givnish & Sytsma	end	hāhā	C	ur
Cyanea sp.	end	hāhā		uv
Trematolobelia macrostachys (Hook. & Arn.) Zahlbr.	end	koliʻi		us
Trematolobelia singularis H. St. John	end		E	us
Casuarinaceae				
Casuarina equisetifolia L.	nat	common ironwood		lr, ls
Cecropiaceae				
Cecropia obtusifolia Bertol.	nat	guarumo, trumpet tree		us
Celastraceae				
Perrottetia sandwicensis A. Gray	end	olomea		ls, us, uv
Convolvulaceae				
Ipomoea alba L.	nat	moon flower, koali pehu		ls, lv
Ebenaceae				
Diospyros hillebrandii (Seem.) Fosberg	end	lama		ls
Diospyros sandwicensis (A. DC.) Fosberg	end	lama		lr, ls, uv
Elaeocarpaceae				
Elaeocarpus bifidus Hook. & Arn.	end	kalia		lr, ls, ur, us
Epacridaceae				
Leptecophylla tameiameiae (Cham. & Schltdl.) C.M. Weiller	ind	pūkiawe		lr, ls, us
Ericaceae				
Vaccinium reticulatum Sm.	end	ʻōhelo		ur, us
Euphorbiaceae				
Aleurites moluccana (L.) Willd.	pol	kukui, candlenut		ls, lv
Antidesma platyphyllum H. Mann var. platyphyllum	end	hame		ls, ur, us, uv

Chamaesyce celastroides (Boiss.) Croizat & O. Deg. var. amplectens (Sherff) O. Deg. & I. Deg.	end	ʻakoko		us
Chamaesyce clusiifolia (Hook. & Arn.) Arthur	end	ʻakoko		ls, ur, us
Fabaceae				
Acacia confusa Merr.	nat	Formosa koa		lr, ls
Acacia koa A. Gray	end	koa		lr, ls, lv, us, uv
Chamaecrista nictitans (L.) Moench var. glabrata (Vogel) H.S. Irwin & Barneby	nat	partridge pea, laukī		lr, ls
Desmodium sandwicense E Mey.	nat	Spanish clover		ls
Senna surattensis (Burm. f.) H.S. Irwin & Barneby	nat	kolomona		lv
Flacourtiaceae				
Xylosma hawaiiense Seem.	end	maua		ls, us
Gesneriaceae				
Cyrtandra cordifolia Gaudich.	end	hahala, haʻiwale, kanawao keʻokeʻo		ls, lv
Cyrtandra garnotiana Gaudich.	end	hahala, haʻiwale, kanawao keʻokeʻo		ls
Cyrtandra hawaiensis C.B. Clarke	end	haʻiwale, kanawao keʻokeʻo		uv
Cyrtandra lessoniana Gaudich.	end	haʻiwale, kanawao keʻokeʻo		us
Cyrtandra sp.	end			us
Goodeniaceae				
Scaevola gaudichaudiana Cham.	end	naupaka kuahiwi		lr, ls, ur, us
Scaevola glabra Hook. & Arn.	end	ʻohe naupaka		ur, us
Scaevola mollis Hook. & Arn.	end	naupaka kuahiwi		ur, us
Hydrangeaceae				
Broussaisia arguta Gaudich.	end	kanawao, pūʻahanui		ls, ur, us
Lamiaceae				
Phyllostegia grandiflora (Gaudich.) Benth.	end	kāpana		ur, us
Phyllostegia lantanoides Sherff	end			us
Loganiaceae				
Labordia hosakana (Sherff) W.L. Wagner, D.R. Herbst & Sohmer	end	kāmakahala	SOC	us
Labordia sessilis A. Gray	end	kāmakahala		us
Labordia waiolani Wawra	end	kāmakahala		us
Lythraceae				
Cuphea carthagenensis (Jacq.) J.F. Macbr.	nat	tarweed, Colombian cuphea		lr
Lythrum maritimum Kunth	ind?	loosestrife, pūkāmole		uv
Malvaceae				
Hibiscus arnottianus A. Gray ssp. arnottianus	end	kokiʻo keʻokeʻo		lv
Hibiscus tiliaceus L.	ind?	hau		ls, lv
Melastomataceae				
*Clidemia hirta (L.) D. Don var. hirta	nat	Koster's curse		lr, ls, lv, ur, us, uv
Pterolepis glomerata (Rottb.) Miq.	nat			lr, ls, ur, us, uv

Meliaceae				
Melia azedarach L.	nat	chinaberry, pride-of-India		ls
Menispermaceae				
Cocculus orbiculatus (L.) DC.	ind	huehue		lr, ls
Moraceae				
Ficus microcarpa L. f.	nat	Chinese banyan		ls, lv
Ficus cf. platypoda (A. Cunn. ex Miq.) A. Cunn. ex Miq.	nat			ls
Myrsinaceae				
Ardisia crenata Sims	nat	Hilo holly, hen's eyes		ur, us
*Ardisia elliptica Thunb.	nat	shoebutton ardisia		ls, lv
Myrsine emarginata (Rock) Hosaka	end	kōlea		ur, us
Myrsine lessertiana A. DC.	end	kōlea lau nui		ls, ur, us
Myrsine sandwicensis A. DC.	end	kōlea lau liʻi		us
Myrtaceae				
Corymbia citriodora Hook.	nat	lemon-scented gum		lr
Eucalyptus robusta Sm.	nat	swamp mahogany		lr, ls
Eucalyptus sp.				lr
Lophostemon confertus (R. Br.) Peter G. Wilson & J.T. Waterh.	nat	vinegar tree, Brisbane box		lr, ls
Melaleuca quinquenervia (Cav.) S.T. Blake	nat	paperbark		lr, us
Metrosideros macropus Hook. & Arn.	end	ʻōhiʻa, ʻōhiʻa lehua		ls, ur, us, uv
Metrosideros polymorpha Gaudich. var. glaberrima (H.Lév.) H. St. John	end	ʻōhiʻa, ʻōhiʻa lehua		lr, ls, lv, ur, us, uv
Metrosideros polymorpha Gaudich. var. incana (H .Lév.) H. St. John	end	ʻōhiʻa, ʻōhiʻa lehua		lr, ls
Metrosideros polymorpha Gaudich. var. polymorpha	end	ʻōhiʻa, ʻōhiʻa lehua		lr, ls, ur, us
Metrosideros rugosa A. Gray	end	lehua papa		ur, us
Metrosideros tremuloides (A. Heller) Knuth	end	lehua ʻāhihi		ur, us
Psidium cattleianum Sabine	nat	strawberry guava, waiawī ʻulaʻula		lr, ls, lv, us
Psidium guajava L.	nat	common guava		lr, ls, lv, uv
Syzygium cumini (L.) Skeels	nat	Java plum		lv
Syzygium malaccense (L.) Merr. & L.M. Perry	pol	ʻōhiʻa ʻai, mountain apple		ls, lv, uv
Syzygium sandwicensis (A. Gray) Nied.	end	ʻōhiʻa hā		lr, ls, ur, us
Nyctaginaceae				
Pisonia brunoniana Endl.	ind	pāpala kēpau		lv
Pisonia umbellifera (G. Forst.) Seem.	ind	pāpala kēpau		lv
Oleaceae				
Nestegis sandwicensis (A. Gray) O. Deg., I. Deg. & L.A.S. Johnson	end	olopua		lr, ls, us
Oxalidaceae				
Oxalis corniculata L.	pol?	yellow wood sorrel, ʻihi ʻai		ls
Passifloraceae				

Passiflora edulis Sims	nat	passion fruit, purple granadilla, liliko‘i		ls, lv
Passiflora laurifolia L.	nat	yellow granadilla, yellow water lemon		lr
Passiflora suberosa L.	nat	huehue haole		lr, ls, lv
Piperaceae				
Peperomia blanda (Jacq.) Kunth var. floribunda (Miq.) H.Huber	ind	‘ala‘ala wai nui		ls
Peperomia latifolia Miq.	end	‘ala‘ala wai nui		uv
Peperomia tetraphylla (G. Forst.) Hook. & Arn.	ind	‘ala‘ala wai nui		lv
Pittosporaceae				
Pittosporum confertiflorum A. Gray	end	hō‘awa		us
Pittosporum glabrum Hook. & Arn.	end	hō‘awa		ls, lv, ur, us
Plantaginaceae				
Plantago pachyphylla A. Gray	end	laukahi kuahiwi		ur
Proteaceae				
Grevillea robusta A. Cunn. ex R. Br.	nat	silk oak, silver oak		lr, ls
Rosaceae				
Rubus rosifolius Sm.	nat	thimbleberry		ls, lv, ur, us, uv
Rubiaceae				
Bobea elatior Gaudich.	end	‘ahakea lau nui		lr, ls, ur, us, uv
Coffea arabica L.	nat	Arabian coffee		lv
Coprosma longifolia A. Gray	end	pilo		ur, us
Gardenia mannii H. St. John & Kuykendall	end	nānū, nā‘ū	E	ls, us, uv
Hedyotis fosbergii W.L. Wagner & D.R. Herbst	end	manono		ur, us
Hedyotis terminalis (Hook. & Arn.) W.L. Wagner & D.R. Herbst	end	manono		ls, ur, us, uv
Nertera granadensis (L. fil.) Druce	ind	mākole		ur
Paederia foetida L.	nat	maile pilau		lr, ls, lv
Psychotria kaduana (Cham. & Schltdl.) Fosberg	end	kōpiko kea		ls, ur, us
Psychotria mariniana (Cham. & Schltdl.) Fosberg	end	kōpiko		lr, ls, ur, us
Psydrax odorata (G. Forst.) A.C. Sm. & S.P. Darwin	ind	alahe‘e		lr, ls
Rutaceae				
Melicope clusiifolia (A. Gray) T.G. Hartley & B.C. Stone	end	kūkaemoa, alani		ls, ur, us
Melicope hosakae (H. St. John) W.L. Wagner & R.K. Shannon	end	alani, alani kuahiwi		ur, us
Melicope oahuensis (H. Lév.) T.G. Hartley & B.C. Stone	end	alani, alani kuahiwi		ur, us
Melicope peduncularis (H. Lév.) T.G. Hartley & B.C. Stone	end	alani, alani kuahiwi		us

Melicope rotundifolia (A. Gray) T.G. Hartley & B.C. Stone	end	alani, alani kuahiwi		ur, us
Melicope wawraeana (Rock) T.G. Hartley & B.C. Stone	end	alani, alani kuahiwi		us
Platydesma spathulata (A. Gray) B.C. Stone	end	pilo kea		us
Zanthoxylum oahuense Hillebr.	end	a'e, mānele	C	us
Santalaceae				
Santalum freycinetianum Gaudich. var. freycinetianum	end	'iliahi, sandalwood		lr, ls
Sapindaceae				
Dodonaea viscosa Jacq.	ind	'a'ali'i		lr, ls, us, uv
Sapotaceae				
Pouteria sandwicensis (A. Gray) Baehni & O. Deg.	end	'āla'a		ls
Solanaceae				
Cestrum nocturnum L.	nat	night cestrum		lv
Solanum seaforthianum Andrews	nat			lv
Thymelaeaceae				
Wikstroemia oahuensis (A. Gray) Rock var. oahuensis	end	'ākia		lr, ls, ur, us, uv
Tiliaceae				
Heliocarpus popayanensis Kunth	nat	moho, white moho		us
Ulmaceae				
Trema orientalis (L.) Blume	nat	gunpowder tree, charcoal tree		ls, lv
Urticaceae				
Boehmeria grandis (Hook. & Arn.) A. Heller	end	'ākōlea		lv, uv
Pilea microphylla (L.) Liebm.	nat	artillery plant, rockweed		lv
Pipturus albidus (Hook. & Arn.) A. Gray	end	māmaki		ls, lv, us, uv
Touchardia latifolia Gaudich.	end	olonā		lv, uv
Urera glabra (Hook. & Arn.) Wedd.	end	ōpuhe		ls
Verbenaceae				
Lantana camara L.	nat	lantana		lr, ls, lv
Stachytarpheta australis Moldenke	nat	ōwī, oī		ls, lv, ur, us, uv
Viscaceae				
Korthalsella complanata (Tiegh.) Engl.	ind	hulumoa		ls, us, uv
MONOCOTS				
Agavaceae				
Cordyline fruticosa (L.) A. Chev.	pol	kī, ti		lr, ls, lv, us, uv
Pleomele halapepe H. St. John	end	hala pepe		ls
Araceae				
Colocasia esculenta (L.) Schott	pol	kalo, taro		lv
Arecaceae				
Pritchardia martii (Gaudich.) H. Wendl.	end	loulu hiwa, loulu		lv, ur, us, uv
Roystonea regia (Kunth) Cook	nat			lv

Bromeliaceae				
Ananas comosus (L.) Merr.	cult	pineapple		lv
Cyperaceae				
Carex meyenii Nees	ind			lr, ls, lv
Carex wahuensis C.A. Mey. ssp. wahuensis	end			ls, lv, us
Cyperus polystachyos Rottb.	ind			ur
Gahnia beecheyi H. Mann	end			lr, ls, ur, us
Kyllinga brevifolia Rottb.	nat	kiliʻoʻopu		lv
Machaerina angustifolia (Gaudich.) T. Koyama	ind	ʻuki		lr, ls, ur, us, uv
Machaerina mariscoides (Gaudich.) J. Kern ssp. meyenii (Kunth) T. Koyama	end	ʻahaniu, ʻuki		lr, us
Rhynchospora rugosa (Vahl) Gale ssp. lavarum (Gaudich.) T. Koyama	ind	puʻukoʻa		ur
Rhynchospora sclerioides Hook. & Arn.	ind	kuolohia		us
Rhynchospora sp.	ind(?)			ur, us
Dioscoreaceae				
Dioscorea bulbifera L.	pol	hoi, bitter yam		ls, lv
Liliaceae				
Dianella sandwicensis Hook. & Arn.	ind	ʻukiʻuki		ls
Musaceae				
Musa xparadisiaca L.	pol	banana, maiʻa		lv
Orchidaceae				
Anoectochilus sandvicensis Lindl.	end	jewel orchid	SOC	us
Arundina graminifolia (D. Don) Hochr.	nat	bamboo orchid		lr, ur, us
Phaius tankarvilleae (Banks ex L'Hér.) Blume	nat	Chinese ground orchid		lv, uv
Spathoglottis plicata Blume	nat	Malayan ground orchid, Philippine ground orchid		lr, ls, lv, ur, us, uv
Indet. orchid	nat			uv
Pandanaceae				
Freycinetia arborea Gaudich.	ind	ʻieʻie		lr, ls, lv, ur, us, uv
Poaceae				
*Andropogon virginicus L.	nat	broomsedge, yellow bluestem		lr, ls, ur
Axonopus fissifolius (Raddi) Kuhlm.	nat	narrow-leaved carpetgrass		lr, ls, ur, us
Dichanthelium koolauense (H. St. John & Hosaka) C.A. Clark & Gould	end		SOC	us
Eragrostis variabilis (Gaudich.) Steud.	end	kāwelu		ls
Isachne distichophylla Munro ex Hillebr.	end	ʻohe		ur, us
Isachne pallens Hillebr.	end			uv
Melinis minutiflora P. Beauv.	nat	molasses grass		ls, us
Oplismenus hirtellus (L.) P. Beauv.	nat	basketgrass, honohono kukui		lr, ls, lv, ur, uv
Panicum maximum Jacq.	nat	Guinea grass		lr
Paspalum conjugatum P.J. Bergius	nat	Hilo grass, sour paspalum		lr, ls, lv, ur, uv
Paspalum scrobiculatum L.	ind?	ricegrass, mauʻu laiki		lr, ur

Pennisetum polystachion (L.) Schult.	nat	feathery pennisetum		ls
Phyllostachys nigra (Lodd.) Munro	nat	black bamboo		lr, ls
Sacciolepis indica (L.) Chase	nat	Glenwood grass		lr, ur, us, uv
Schizostachyum glaucifolium (Rupr.) Munro	pol?	ʻohe		lv
Setaria palmifolia (J. Kōnig) Stapf	nat	palmgrass		lr, ls, lv, ur, uv
Setaria parviflora (Poir.) Kerguélen	nat	yellow foxtail		lr, ls, ur, us
Smilacaceae				
Smilax melastomifolia Sm.	end	hoi kuahiwi		lr, ur, us
Zingiberaceae				
Hedychium sp.	nat			lv
Zingiber zerumbet (L.) Sm.	pol	ʻawapuhi, shampoo ginger		ls, lv
GYMNOSPERMS				
Araucariaceae				
Araucaria columnaris (G. Forst.) Hook. f.	nat			ls
PTERIDOPHYTES				
Aspleniaceae				
Asplenium horridum Kaulf. var. horridum	ind	ʻiwa, ʻalae		ls
Asplenium nidus L.	ind	ʻēkaha, bird's-nest fern		ls, lv
Asplenium polyodon G. Forst.	ind	pūnana manu		uv
Athyriaceae				
Athyrium microphyllum (J. Sm.) Alston	end	ʻākōlea		us
Deparia petersenii (Kunze) M. Kato	nat			ls, lv, us, uv
Deparia prolifera (Kaulf.) Hook. & Grev.	end			lv, us, uv
Blechnaceae				
Blechnum appendiculatum Willd.	nat			lr, ls, lv, ur, us, uv
Sadleria cyatheoides Kaulf.	end	ʻamaʻu		ur
Sadleria pallida Hook. & Arn.	end	ʻamaʻu ʻiʻi		ls, ur, us
Dennstaedtiaceae				
Pteridium aquilinum (L.) Kuhn var. decompositum (Gaudich.) R.M. Tryon	end	kīlau, bracken fern		lr, ls
Dicksoniaceae				
Cibotium chamissoi Kaulf.	end	hāpuʻu		lr, ls, lv, ur, us, uv
Cibotium glaucum (Sm.) Hook. & Arn.	end	hāpuʻu, hāpuʻu pulu		lr, ls, ur, us
Cibotium menziesii Hook.	end	hāpuʻu ʻiʻi		lr, ls, ur, us
Dryopteridaceae				
Tectaria gaudichaudii (Mett.) Maxon	end	ʻiwaʻiwa lau nui		us, uv
Elaphoglossaceae				
Elaphoglossum alatum Gaudich.	end	hoe a Māui, ʻēkaha		uv
Elaphoglossum crassifolium (Gaudich.) W.R. Anderson & Crosby	end	hoe a Māui, ʻēkaha		ls, ur, us
Elaphoglossum fauriei Copel.	end	hoe a Māui, ʻēkaha		us
Gleicheniaceae				

Dicranopteris linearis (Burm. f.) Underw. f. linearis	ind	uluhe		lr, ls, ur, us, uv
Diplopterygium pinnatum (Kunze) Nakai	end	uluhe lau nui		ls, ur, us
Grammitidaceae				
Adenophorus haalilioanus (Brack.) K.A. Wilson	end			us
Adenophorus hymenophylloides (Kaulf.) Hook. & Grev.	end	pai, palai huna		us, uv
Adenophorus oahuensis (Copel.) L.E. Bishop	end			us, uv
Adenophorus pinnatifidus Gaudich. var. pinnatifidus	end			uv
Adenophorus tamariscinus (Kaulf.) Hook. & Grev. var. tamariscinus	end	wahine noho mauna		lr, ls, ur, us, uv
Grammitis hookeri (Brack.) Copel.	end	māku‘e lau li‘i		us
Grammitis tenella Kaulf.	end	kolokolo, mahinalua		lr, ls, ur, us
Hymenophyllaceae				
Gonocormus minutus (Blume) Bosch	ind			lv
Mecodium recurvum (Gaudich.) Copel.	end	‘ōhi‘a kū		us, uv
Sphaerocionium lanceolatum (Hook. & Arn.) Copel.	end	palai hinahina		lv, ur, us, uv
Sphaerocionium obtusum (Hook. & Arn.) Copel.	end	palai lau li‘i		uv
Vandenboschia cyrtotheca (Hillebr.) Copel.	end			uv
Vandenboschia davallioides (Gaudich.) Copel.	end	palai hihi, kīlau		uv
Lindsaeaceae				
Sphenomeris chinensis (L.) Maxon	ind	pala‘ā		lr, ls, ur, us, uv
Lycopodiaceae				
Huperzia erubescens (Brack.) Holub	ind			ur, us
Huperzia phyllantha (Hook. & Arn.) Holub	ind	wāwae‘iole		ls, uv
Lycopodiella cernua (L.) Pic. Serm.	ind	wāwae‘iole		lr, ur, us
Marattiaceae				
Angiopteris evecta (G. Forst.) Hoffm.	nat	mule’s-foot fern		lv
Nephrolepidaceae				
Nephrolepis cordifolia (L.) C. Presl	ind			ls
Nephrolepis exaltata (L.) Schott ssp. hawaiiensis W.H. Wagner	end	ni‘ani‘au, ‘ōkupukupu		lr, ls, us
Nephrolepis multiflora (Roxb.) F.M. Jarrett ex C.V. Morton	nat			lr, ls, lv, uv
Ophioglossaceae				
Ophioderma pendulum (L.) C. Presl ssp. falcatum (C. Presl) R.T. Clausen	ind	puapua moa, laukahi		lr, ls, us
Polypodiaceae				
Lepisorus thunbergianus (Kaulf.) Ching	ind	pākahakaha		ls, lv, uv
Phlebodium aureum (L.) J. Sm.	nat	laua‘e haole		lr, ls, lv

Phymatosorus grossus (Langsd. & Fisch.) Brownlie	nat	laua‘e, maile-scented fern		lr, ls
Psilotaceae				
Psilotum complanatum Sw.	ind	moa, flat-stemmed whiskfern		lr, ls, uv
Psilotum nudum (L.) P. Beauv.	ind	moa, upright whiskfern		lr, ls, lv, uv
Pteridaceae				
Adiantum raddianum C. Presl	nat			lv, uv
Cheilanthes viridis (Forssk.) Sw.	nat	green cliff brake		ls
Schizaeaceae				
Schizaea robusta Baker	end	‘ōali‘i makali‘i		us
Selaginellaceae				
Selaginella arbuscula (Kaulf.) Spring	end	lepelepe a moa		lv, uv
Thelypteridaceae				
Amauropelta globulifera (Brack.) Holttum	end	palapalai a Kamapua‘a		us
Christella cyatheoides (Kaulf.) Holttum	end	kikawaiō		ls, lv, uv
Christella dentata (Forssk.) Brownsey & Jermy	nat	pai‘i‘ihā		lv, us, uv
Christella parasitica (L.) Lév.	nat			lr, ls, lv, ur, us, uv
Pneumatopteris sandwicensis (Brack.) Holttum	end	hō‘i‘o kula		us
Vittariaceae				
Haplopteris elongata (Sw.) E.H. Crane	ind	‘ohe‘ohe, mana		ls