Botanical Survey
of
Hoʻomalu Kaʻū Property

Hoʻomalu Kaʻū

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Report Prepared
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Summary

The Hoʻomalu Kaʻū property is located adjacent to the southeast side of the Manukā Natural Area Reserve. The property is occupied by ʻōhiʻa *(Metrosideros polymorpha)* dry forest. The understory is highly variable but dominated by native plants and almost completely free of weeds except in few disturbed areas around the edges of the property. In many parts of the property, the understory is dominated by a rich assemblage of native shrubs and trees including lama, pilo, māmane, ʻākia, kōlea, ʻōpiko, pūkiawi, ʻūlei, and manono. A low to moderate level of damage to native plants from feral animals and insects is present throughout the site. Geologically, the property is a series of overlapping ʻaʻā flows (750 -1500 ybp) as can be seen by the steep flow edges encountered as one transects from the makai property line up toward the highway. In the southeast part of the property older (3000 ybp) pāhoehoe remains exposed and uncovered by the younger ʻaʻā flows. Several places on the property are rich in native plants and provide good examples of many of the species on the property. Some of these places could be incorporated into a proposed nature trail that would follow the ancient trail that crosses the property.

Introduction

Ho'omalu Ka'ū is a community based non-profit organization based in Nā'ālehu, Hawai'i Island. Ho'omalu Ka'ū has recently been graced with a remarkably intact, fifteen-acre parcel of native Hawaiian dry forest adjacent to the south side of Manukā Natural Area Reserve (Figure 1). This site represents a unique oportunity to expand the effective protected area of the reserve and to provide a site for public education about Hawaiian cultural practices and native Hawaiian forests and the plants and animals they support.

This document reports the results of a botanical survey of the Ho'omalu Ka'ū property. Anyone interested in native Hawaiian dry forest biology and conservation will find the information presented here relevant to the understanding and preservation of all Hawaiian dry forest habitats.

The report first describes the general features of the Ho'omalu Ka'ū property and characteristics of the 'ōhi'a *(Metrosideros polymorpha)* forest. Important sites on the property for native plants are described. Then a selection of important native plant species are discussed and their distribution mapped based on their occurrence in sample plots.

Figure 1. Location of the Ho'omalu Ka'ū property on the Island of Hawai'i.

Figure 2. Hoʻomalu Kaʻū property showing corner designations as referred to in the text.

Figure 3. Hoʻomalu Kaʻū property from the air (lower angle than above). Barren rock appears brown in this color-enhanced image; dark green areas support high shrub cover.

Field surveys were carried out to document the present flora and vegetation of the site and to describe and document floristicly rich or important areas. The surveys intended to locate interesting native plants occurring along the ancient trail that runs across the property. Eventually, the trail could be developed into an educational nature trail. The field surveys also searched for any federally or state listed endangered or threatened species or species of concern .

The scope of the field survey was necessarily limited by time and financial resources. All field surveys are affected by the variation from year to year in climate patterns and other factors, so that results found in one year or season may differ from those found in another.

This study is primarily a botanical survey focused on native plants on the Hoʻomalu Kaʻū property. Even so, the field team compiled lists of all animals encountered during the field surveys including birds, mamals, reptiles, and insects. No special expertise with any of these groups is claimed here and, unlike the plants, no particular sampling protocols were used for animals. All animal species were recorded as the field team encountered them.

The ʻōhiʻa forest in the study area is rich in native plants and is essentially weed free except along the road shoulder of Māmalahoa Highway and in the cleared area along the highway on the northeast part of the highway frontage. Apparently, the forest is suffering from extreme long-term drought and over the past decade has developed severe die-back on many of the ʻōhiʻa. Not all trees are affected. More worrisome is a lack of ʻōhiʻa seedling regeneration. Feral animals are browsing the forest but at a low level of intensity and insect and disease damage to some native plants is occurring.

Part of the significance of the forest on the Hoʻomalu Kaʻū property is that the property is adjacent to and contiguous with the Manukā Natural Area Reserve along the western property boundary. The ʻōhiʻa forest on the Hoʻomalu Kaʻū property is continuous with the adjacent forest on the Manukā Natural Area Reserve. The Hoʻomalu Kaʻū property will essentially add an additional fifteen acres of protected forest land adjacent to the reserve. This is significant because nearly all the original dry forest in Hawaiʻi has been destroyed. What remains is in a few protected areas such as Manukā Natural Area Reserve.

A rough bulldozer trail runs from the Kāheawai Trail head at the north-west corner of the property makai to the southwest corner along the west property line. The northern boundary of the property fronts along Māmalahoa Highway. A cleared area occurs adjacent to the highway near the east end of the property and is the planned location of the Heritage Center of Kaʻū. A fence occurs all along the east property line.

The Hoʻomalu Kaʻū property is archeologically significant. The north west corner of the Hoʻomalu Kaʻū property overlaps the beginning of the ancient Kāheawai Trail (the "road to the sea"-"water calling"- the chief who loudly called for water); and an ancient trail, also used in historical times, runs across the property (Figure 26). An archeological survey of the property was recently conducted by Robert Rechtman, Ph.D.

Climate

The Hoʻomalu Kaʻū property elevation is just under 2000 feet at Māmalahoa Highway. Historical averages for precipitation at Manukā (weather station "Manukā 2") are shown in Figure 4. ʻŌhiʻa Dry Forest, such as occurs on the Hoʻomalu Kaʻū property, is generally considered to occur at rainfall amounts averaging less than 50 inches a year. Normal precipitation at Manukā 2 has in the past fluctuated around 30 inches annually but since 2008 rainfall totals have been significantly below that amount. In fact, most of West Hawaiʻi Island has been enduring a five to seven year drought at this writing.

The property has a southwest exposure, exposing it to the hot afternoon sun and increasing evapotranspiration. Average temperatures vary from the high 80's in August and September, to the mid 60's in January.

Geology

The geology of the Hoʻomalu Kaʻū property is complex (Figure 5). Lava flows from Mauna Loa of various ages make up the slope on which the property is located. The property itself consists of a series of overlapping ʻaʻā lava flows dated between 750 and 1500 years b.p. ("before present" - Sherrod, et al. 2007 and Figure 5). In the southwest corner of the property, about an acre of older (3000 years b.p) pāhoehoe remains uncovered by the later, more recent ʻaʻā flows. These ʻaʻā flows were obviously formed as a series of progressively later events, each partially overlapping the earlier flow. The property thus comprises a series of steep flow edges, encountered one after the other, as one transects from the makai side of the property to the mauka side at the highway. The ʻaʻā flows are very rough and of large scale. Mineralogically, they are classified as Kaʻū Basalt (Wolfe and Morris 1996).

Vegetation Classification

Different authors have developed different classification systems for the natural vegetation of Hawaiʻi. Most biologists would classify the forest vegetation of the Hoʻomalu Kaʻū property as ʻŌhiʻa Dry Forest. The forest on the property contains some plant species more characteristic of moist (mesic) forest and thus is difficult to classify to a more detailed level in most of the current Hawaiian vegetation classification systems (Gagne and Cuddihy 1990; Sohmer and Gustafson 1987).

Regardless of the classification system used, the dry forest occurs as a mosaic of different vegetation types over the various lava flow series on the slopes of Mauna Loa. Lava substrates of different ages and minerological composition support vegetation dominated by different combinations of native shrubs and trees. The rarest natives are sometimes restricted to particular lava flows.

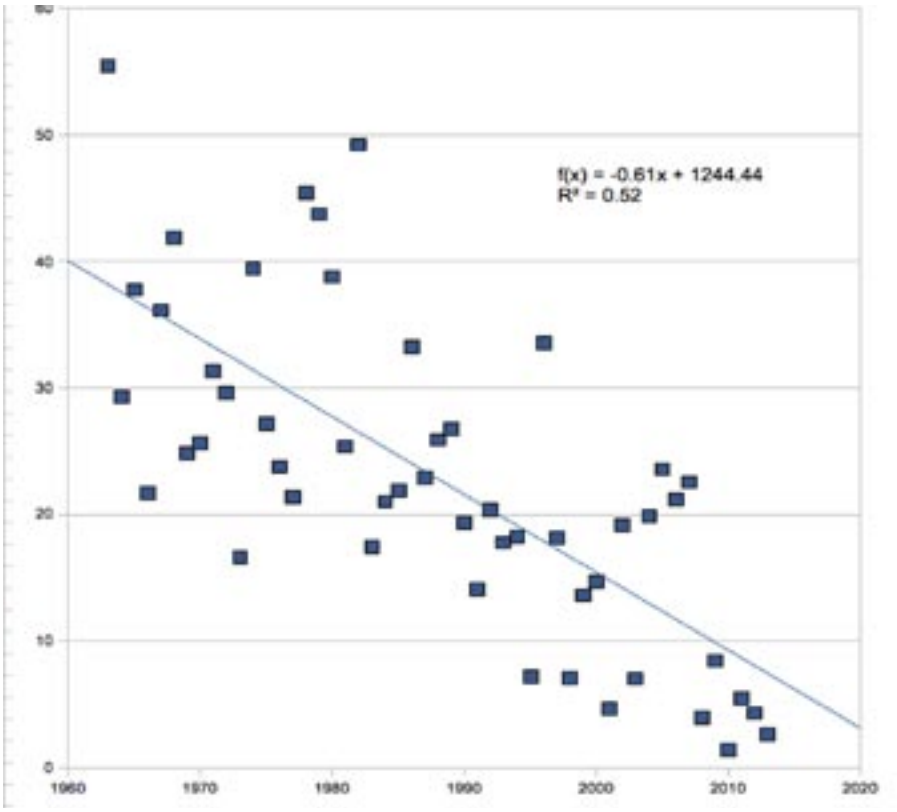


Figure 4. Annual rainfall totals at weather station "Manukā 2" between 1963 and 2013. Rainfall has been trending down for decades and has been well below normal since 2008.

Figure 5. Geologic map (Sherrod, et al. 2007) showing the various lava flows from Mauna Loa in the vicinity of the Hoʻomalu Kaʻū property (HK). Most of the property is classed as 750 - 1500 ybp. A small area of older lava (3000 ybp.) is found in the southeast corner of the property.

Methodology

Field surveys were conducted by Rex Palmer, Ph.D. and field assistants. Field visits were conducted on February 3, 6, 10, 13, 18, 21, and March 3, 2014. Previous botanical studies, maps, and air photos were consulted before fieldwork was begun to determine areas that might be botanically important, and to plan field days.

A complete list of all vascular plant species encountered on the property is presented at the end of this report (Appendix). Plants were identified in the field. Any material not so identifiable was collected for later determination. Nomenclature of native and naturalized plant species follows Wagner, Herbst, and Sohmer (1999). Nomenclature of cultivated or landscape plants follows Staples and Herbst (2005), Neal (1965), and Uhl and Dransfeld (1987). Certain nomenclature has been updated to conform to Kew (2010) and Wagner, et al. (2012). U. S. Fish and Wildlife Service designations follow USFWS (2007).

The field team carried out a visual survey, on foot, over the entire property. In the field, a combination of "timed meander" (Nelson, 1987, Palmer, et al. 1987) walk-through surveys, transects, and sample plots were used to ensure coverage. Particular attention was paid to rare species that might be present on the site.

So many individuals of each of the native tree and shrub species were present on the property that it was impractical to map each plant. Instead, a series of twenty-five 10 meter by

Figure 6. Master GPS sample point map plotted using Google Maps.

10 meter sample plots, on 9 transects were set up (using the method of Braun-Blanquet, 1965) and the species present in each plot recorded. For each species in the plot, a "cover-abundance" figure was assigned using the Domin cover-abundance scale (Mueller-Domboi and Ellenberg (1974). Some plant locations on transects or meanders are also shown.

The sample plot data is shown in Tables I and II. In the first table, the species are arranged alphabetically. In the second table, the species are arranged according to "constancy" (C in the table), that is, their frequency of occurrence in the plots. Species with high constancy, such as ʻōhiʻa, occur in all or most of the plots. Species with low constancy occur in only some sample plots.

Sample plots containing each species were mapped using GPS (satellite Global Positioning System) to show the relative distribution of that species across the property (Figures 29 through 57). Note that these points are not all of the physical locations on the property of each of the species shown. The mapped points do not represent individual plants but rather indicate GPS locations of sample plots in which the species occur. As such, they give a general idea of the distribution and relative abundance of native plants over the property. A few additional points were added to the maps to account for locations of plants encountered in meander surveys, otherwise locations are plot occurrences.

GPS coordinates were determined in the field using a Garmin hand-held GPS receiver. Datum used was WGS84. All coordinates were converted to decimal degrees and mapped using Google Maps. Figure 6 shows the matrix of GPS points for sample plots and transects on the property.

Unless otherwise noted, photographs in this report are by Palmer & Associates and were taken in the field on the Hoʻomalu Kaʻū property. Line drawings are taken from Wagner, et al. 1999 and from drawings available on the internet.

Animals were identified using various references including Jamieson & Denny (2001), Howarth & Mull (1992), and Tomich (1986).

Results

Floristics of Ho'omalu Ka'ū property - plant checklist, rare plants

A complete list of all vascular plants, including ferns and lower vascular plants, encountered during the field surveys is presented in the Appendix. One hundred and nine species of vascular plants were encountered on the site during the field surveys. Of these, sixy-eight (approximately 65%) were introduced alien species; sixteen (approximately 15%) were indigenous native plants (found naturally in Hawai'i and other parts of the Pacific); and twenty-one (approximately 20%) were endemic (found naturally only in Hawai'i) native Hawaiian plants. Three additional native plants reported from the site in the past brings the total number of plant species up to one hundred and twelve vascular plant species.

The high percentage of alien plants shown above does not reflect the flora of the property as a whole. Most of the aliens are adventive, ruderal weeds associated with the existing cleared parking and building site area along the highway. A few of the weeds are found on the bulldozer track on the north side of the property and along the south fence line, but the vast majority are associated with the highway site. In fact, the forest on the property is remarkable for the lack of invasive species throughout most of the area and the abundance of native plants.

No federally listed Endangered, Threatened, or Candidate plant species were found during the field surveys reported here. One "species of concern", *Fimbristylus hawaiiensis* (no recognized Hawaiian name), a diminutive sedge-like plant, was found in the northwest part of the property on the bulldozer trail and at the top of the Kāheawai Trail (Figures 7,8,9).

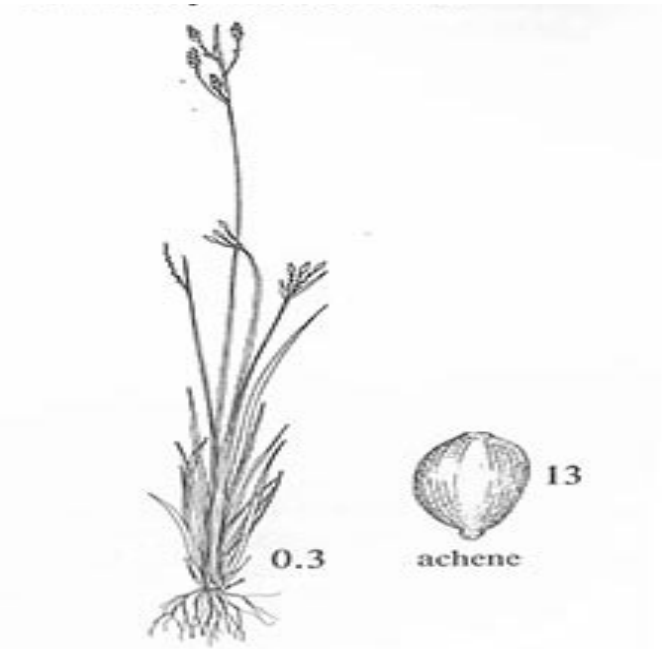


Figure 7. *Fimbristylis hawaiiensis.* From (Wagner, et al. 1999)

Figure 8. *Fimbristylis hawaiiensis.* Plants are only about 4 inches tall.

Figure 9. Occurrences of *Fimbristylus hawaiiensis* a USFWS "species of concern".

The species is not in any immediate danger and is protected in the forest reserves and in Hawai'i Volcanoes National Park.[1]

Many plants were found (see Appendix) that are on the State of Hawai'i's list of "species of greatest conservation need" (DLNR 2005). These are unique native endemic and indigenous Hawaiian species that are considered critical components of Hawai'i ecosystems. Many of these species, although not officially listed by the state or federal government, are severely under threat over all or part of their range.

'Ōhi'a die-back

'Ōhia die-back is extensive throughout the Ho'omalu Ka'ū property. The forest seems to be undergoing a gradual change from a mesic (moist) forest to a mosaic of dry forest and shrubland. Observations made by the authors in October of 2007 along the Kāheawai Trail adjacent to the west edge of the property indicate that far less 'ōhi'a die-back was occurring at that time than at present (February 2014). In 2007 the 'ōhi'a canopy was providing considerably more shade for understory plants than it now does. Very few trees had dead tops. This dramatic increase in die-back correlates with a period of long-term drought in West Hawai'i (Figure 4).

Dead tree ferns, both hāpu'u *(Cibotium glaucum*) and 'ama'u *(Sadleria cyathioides),* were found on the Ho'omalu Ka'ū property, indicating wetter conditions in the recent past. In some

[1] Another USFWS species of concern, a kauila (*Alphitonia ponderosa),* was reported as a single dead individual by Rick Warshaur in 2013. It has not been relocated.

parts of the property, shrubs are now dominating the vegetation in open areas produced as the ʻōhiʻa canopy has thinned out.

ʻŌhiʻa die-back is complex multi-variable phenomenon and many researchers have studied it over the years. Die-back has different causes in different places. In the wet forest on Saddle Road researchers found (after discounting vog and pests) that after a single colonization event a cohort of trees of similar age is produced that die off together, allowing new trees to regenerate the forest. In the wet forest, die-back is therefore a natural event.

The ʻōhiʻa forest on the Hoʻomalu Kaʻū property shows a size-class distribution that contains only mature trees, implying a single colonization event. However, there is a complete lack of ʻōhiʻa regeneration on the property. Even though many of the ʻōhiʻa trees on the property were observed to be making seeds, not a single ʻōhiʻa seedling was encountered during the field surveys. This is in stark contrast to the situation on the windward side of the island, where ʻōhiʻa seedlings appear quickly in open areas. Lack of ʻōhiʻa regeneration on the Hoʻomalu Kaʻū property implies that drought or some other factor, rather than natural cohort die-off is causing the observed condition of the forest.

Jacobi (2012) has recently established a number of study areas on Hawaiʻi Island to examine ʻōhiʻa die-back. One of these study areas is in Manukā Natural Area Reserve. This research should provide a better future understanding of die-back in the ʻōhiʻa forest in this area.

Despite extensive ʻōhiʻa die-back on the Hoʻomalu Kaʻū property, there are still many mature ʻōhiʻa in very good shape, without significant die-back. These tend to be larger trees (up to 24" DBH), apparently growing in favorable sites (larger size-class trees indicating favorable sites rather than significantly greater age). Many ʻōhiʻa with die-back in the tops have side branches that are not dead (Figure 12). Many of the ʻōhiʻa are multi-stemmed, some stems having dead tops while other stems on the same tree are green and fully leafed out. Furthermore, ʻōhiʻa die-back is not uniformly distributed throughout the property, some places having more dead material than others.

Feral animals and introduced pests

Field surveys revealed that feral animals have been damaging the vegetation on the property, although at present the damage is relatively light. At various times, the field team observed goats, pigs, and turkeys adjacent to the property. Native shrubs such as māmane *(Sophora chrysophylla)* showed evidence of goat browsing (Figure 15) and dead tree ferns showed pig damage. A resident wild goat herd, which can be seen periodically along the highway, moves through the general area regularly.

Other introduced pests damaging the forest found during the surveys include stem-boring beetles (evidenced by their burrows in the stems of some of the native trees - Figure 16). A blight was found occurring on some ʻaʻaliʻi *(Dodonaea viscosa*), producing shriveled leaves and branches. Two lama trees *(Diospyros sandwicensis)* were found that were diseased with *Agrobacterium*, a bacterial blight.

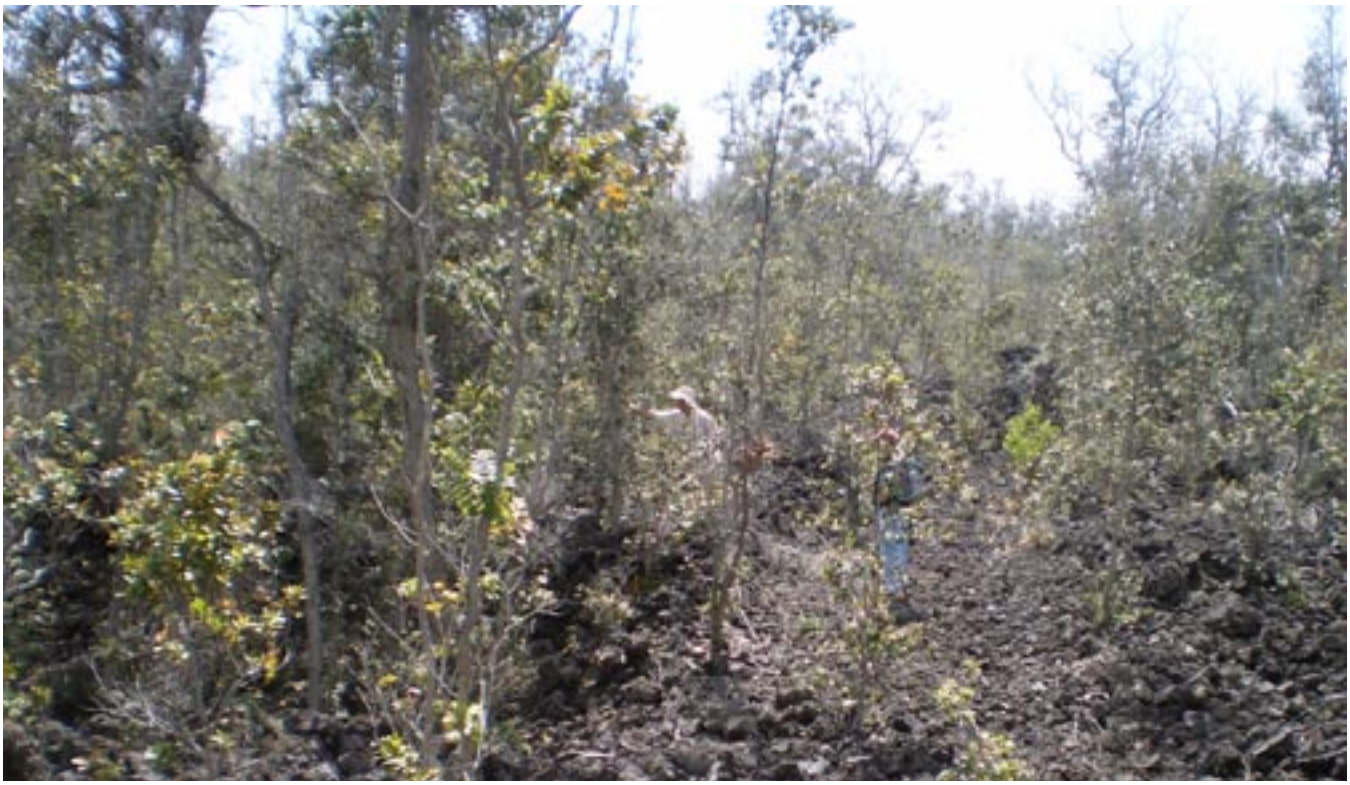


Figure 10. Near top of bulldozer trail. Low stature ʻōhiʻa forest with widespread die-back.

Figure 11. High point near begining of transect 1 looking SE. Die-back is widespread but not all trees are affected.

Figure 12. Only parts of some trees are affected by die-back, with side shoots continuing to grow.

Figure 13. A mix of die-back and large, healthy trees is common throughout the property.

Animals encountered on the Hoʻomalu Kaʻū property

Animals found on the Hoʻomalu Kaʻū property are summarized in the Appendix. Birds of note include native Hawaiian ʻapapane *(Himatione sanguinea).* Although none were observered, there are reports by local residents of ʻio (Hawaiian Hawk - *Buteo solitarius*). A single, large Jackson's Chameleon *(Trioceros jacksonii*) was encountered (Figure 14).

Field surveys reported here were conducted during daylight hours so there was little chance to observe ʻōpeʻ apeʻa (Hawaiian Bat - *Lasirus cinereus semotus*). However, bats are known from Manukā Natural Area Reserve and anecdotal reports of bats by local residents indicate that they are probably present on or near the property.

Pinao *(Anax pacifica)*, the native Hawaiian dragonfly was observed. Numerous species of moths were observed on the property, most of them alien. Insects encountered during the surveys are listed in the Appendix.

The Hoʻomalu Kaʻū property is within the historic range of the native Hawaiian Blackburn's Sphinx Moth *(Manduca blackburni)*, a federally listed endangered species. Historically, larvae of the species fed on ʻaeia *(Nothocestrum breviflorum)* but in recent times it has shifted its food source to tree tobacco *(Nicotiana glauca)* and other nightshade family (Solanaceae) plants. No Blackburn's Sphinx Moths were observed on the Hoʻomalu Kaʻū property during the surveys and no tree tobacco or ʻaeia were found. The only nightshade family species encountered was pōpolo *(Solanum americanum).*

Figure 14. The non-native Jackson's Chameleon *(Trioceros jacksonii*) in the Hoʻomalu Kaʻū forest.

Figure 15. Māmane *(Sophora chrysophylla)* showing goat browsed stem tip.

Figure 16. Stem borer hole in ʻōpiko *(Psychotria mauiensis)* stem.

Important botanical areas on the Hoʻomalu Kaū property:

Although the entire property is important habitat, some areas within the forest are of particular floristic interest or are illustrative of a particular forest plant association. At many points in the forest on the property interesting native plants occur in relative abundance. These areas are indicated on the air photo in Figure 17. In the figure the boundaries of these areas are artificial, drawn simply for convenience. They are intended to indicate general areas only and do not indicate the boundaries of "vegetation types".

1. Hōʻawa area (Figure 18)

One of the best areas for viewing some of the more interesting understory trees and shrubs, such as hōʻawa (*Pittosporum hosmeri*) is between the highway and the ancient trail (Figures 17 - Area 1, Figure 18).

This site has an ideal location for incorporation into a future nature trail. It has not only hōʻawa, but also good examples of nearly all of the shrub and tree species found on the property. The spot is easily reached from the roadside over a bare strip of relatively flat ʻaʻā that could easily be made into a simple trail to the spot and could then connect to the ancient trail.

Figure 17. Locations of floristically important areas on site: 1. Hōʻawa area; 2. SE corner; 3. Bulldozer trail and SW corner; 4. Hulumoa area; 5. ʻAʻā flow on NE side of property; 6. Corridor along ancient trail; 7. Central forest area.

Figure 18. Hōʻawa area. Hoʻomalu Kaʻū volunteer Tom Schnetlage photographing hōʻawa *(Pittosporum hosmeri).*

2. Southeast corner and south property line (Figure 19)

This area features abundant lama and large ʻōhiʻa growing on and near the makai property line. A small portion of older pāhoehoe lava flow is exposed in the southeast corner and vicinity (Figure 19). Vegetation on this old pāhoehoe lava is very open (low ʻōhiʻa cover-abundance) ʻōhiʻa forest with large portions dominated by a mix of native shrubs.

Good geological examples of ʻaʻā flow covering over the older pāhoehoe occur in this area, with flat pāhoehoe lava ending in fifteen foot escarpments at the terminus of the overlying ʻaʻā flow.

3. Southwest corner and bulldozer track on west side of property (Figures 20 & 21)

The bulldozer path that follows the diagonal west property line leads directly into ʻōhiʻa forest that supports numerous interesting native plant species. One can see most of the plant species that occur on the property on a walk down the bulldozer trail to the south west corner.

ʻŌhiʻa forest in this area is of relatively low stature, with trees averaging 25 - 30 feet tall. Many of the ʻōhiʻa show "die-back" tops above 20 feet. ʻŌhiʻa here are scrubby in form, many having multiple stems and approaching the growth form of arborescent shrubs.


Figure 19. Portion of 3000 year-old pāhoehoe exposed in southeast corner of property.

A single tree will often have a main trunk with die-back and numerous shorter side branches from the same stem base or root crown that show little or no die-back.

Between the ʻōhiʻa trees, the extremely, rocky terrain is occupied by a rich mixture of native trees and shrubs. Trees include: lama *(Diospyros sandwicensis)*, ʻōpiko *(Psychotria mauiensis),* kōlea *(Myrsine lanaiensis)*, and alaheʻe *(Psydrax odorata)*. Shrubs include: ʻaʻaliʻi *(Dodonaea viscosa)*, pūkiawe *(Leptecophylla tameiameiae)*, and ʻākia *(Wikstroemia phillyreifolia)*.

4. Hulumoa *(Korthallsella remyana)* area (Figure 22)

Near the Kāheawai Trail head and within twenty feet of the north property line along Māmalahoa Highway, a site with many of the ʻōhiʻa supporting hulumoa *(Korthallsella remyana)* occurs. Hulumoa is a native Hawaiian parasitic plant on ʻōhiʻa and other native trees. Although parasitic, hulumoa rarely causes significant damage to the host tree.

5. ʻAʻā flow on east side of property (Figure 23)

This ʻaʻā lava flow (about 750 ybp.), the surface of which is raised 20 or more feet in places above the older flow upon which it rests, supports a sparse vegetation, somewhat desert-like with much of the surface barren rock. ʻŌhiʻa trees and associated shrubs cluster around small scattered sites where more favorable conditions apparently occur.

Figure 20. ʻŌhiʻa forest with die-back and understory of native trees and shrubs at southwest corner of property.

Figure 21. ʻŌhiʻa forest along bulldozer track.

Figure 22 . Hulumoa *(Korthalsella remyana)*.

Figure 23. ʻAʻā flow on south side of property.

6. Ancient trail (Figures 24, 25 & 26)

The location of the ancient trail that crosses the Hoʻomalu Kaʻū property is shown in Figure 26. This map was taken from the recent archaeological survey of the property. Although no rare or endangered native plants occur along the ancient trail, good examples of many of the common native plants on the property are scattered all along the trail (Figures 24 and 25). A botanical corridor all along the trail is shown in Figure 17.

On the eastern end of the trail, makai of the cleared area, are good examples of spots where the trail is built up with stonework or a road cut has been made through the ʻaʻā. The eastern end of the trail is open die-back forest with examples of many of the shrub species found on the property. A few lama also occur near the eastern end of the trail.

Clearly visible, built-up sections of trail are also present on the western end. Native plants characteristic of more moist, shaded forest occur where the trail comes close to the hōʻawa area and continue west at various points along the trail to the bulldozer track on the western boundary. Parts of the western half of the trail are obscure and very overgrown and difficult to pass through at the present time.

The field team flagged and labeled examples of native plants along the trail at various locations.

Figure 24. Part of ancient trail traversing the Hoʻomalu Kaʻū property.

Figure 25. Portion of ancient trail with pūkiawe and ʻaʻaliʻi growing in the middle of the trail.

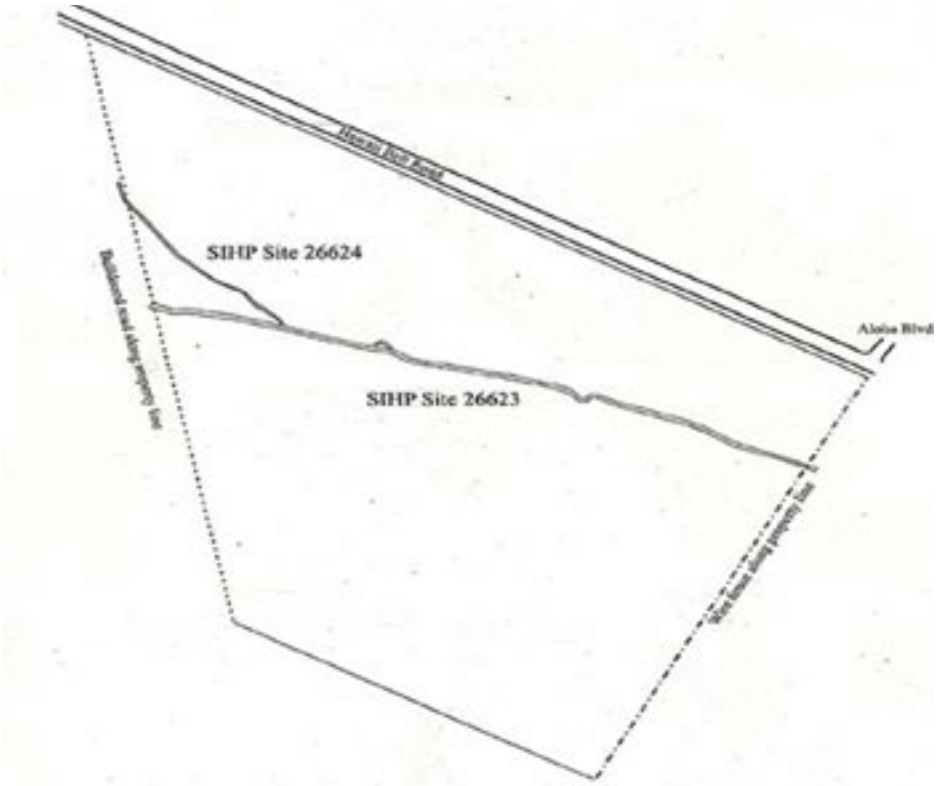


Figure 26. Archeology map of ancient trail.

7. Central forest area (Figure 27)

The central forest area is a relatively flat expanse of ʻaʻā lava dominated by low-stature ʻōhiʻa with some die-back, forming a thin canopy. The understory is dominated by a thick growth of shrubs, particularly māmane *(Sophora chrysophylla)*. Other shrubs abundant here include pūkiawe *(Leptecophylla tameiameiae)* and ʻaʻaliʻi *(Dodonaea viscosa)*.

Figure 27. View of central forest area from high point looking southeast, showing open ʻōhiʻa canopy and dense shrub layer.

Distribution of selected native Hawaiian plants on the property

Figures (29 - 57) show locations where various native tree and shrub species were encountered during the field surveys. The occurrences of lava fern are also mapped. Many, but not all native plant species found on the property are mapped in this report. Most of the occurrences shown on the maps are based on Tables I and II, which show the cover/abundance of plant species in sample plots. The presence of species in sample plots give a picture of the distribution of each species over the property. Each of these native plant species is discussed below.

ʻŌhiʻa
(*Metrosideros polymorpha* var. *polymorpha* and varieties)

The common variety of ʻōhiʻa (*Metrosideros polymorpha* var. *polymorpha*) occurs throughout the forest on the property and comprises the dominant tree in all the sample plots and transects. Most of these ʻōhiʻa are from 3 to 10 inch DBH (Diameter at Breast Height) and from 20 to 40 feet tall, with necrotic tips (die-back) above 20 ft. (see discussion of die-back on page 9). Portions of the property support somewhat larger ʻōhiʻa (24 inch DBH) forest. ʻōhiʻa cover varies from 40 to 60 percent.

Two other varieties of ʻōhiʻa also occur: *M. polymorpha* var. *glaberrima* and *M. polymorpha* var. *incana*. These are found sporadically along with *M. polymorpha* var. *polymorpha*. *M. polymorpha* var. *glaberrima* differs from the common variety *polymorpha* by leaf shape and lack of pubescence; *M. polymorpha* var. *incana* differs in leaf shape and the presence of appressed pubescence on the lower leaf surface.

Figure 28. ʻŌhiʻa lehua *(Metrosideros polymorpha var. polymorpha).*

ʻĀkia
(Wikstroemia phillyreifolia)

Twelve species of ʻākia occur in Hawaiʻi and all are endemic (found only in Hawaiʻi). Different species of ʻākia occur on different islands. *W. phillyreifolia* is a common species on Hawaiʻi Island.

W. phillyreifolia is a shrub or small tree with small, greenish flowers. ʻĀkia is found from sea level up to almost 7000 ft. elevation and is a common native in the vegetation in Puna and Kaʻū.

When in flower, ʻākia has a sweet fragrance. It is one of the most important cordage plants known because of its extremely strong fibers. ʻĀkia was also used medicinally by the Hawaiians. The crushed fruits were used to stun fish.

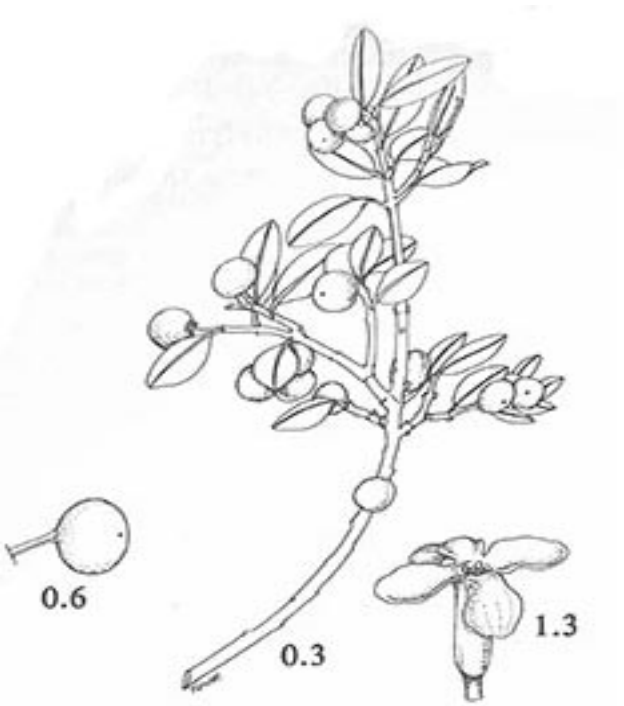


Figure 29. Locations of field samples with ʻākia *(Wikstroemia phillyreifolia).*

Figure 30. ʻĀkia *(Wikstroemia phillyreifolia)* growing as a small tree at the SW corner of the property at the intersection of the bulldozer trail and the corner.

Figure 31. ʻAʻaliʻi (Dodonaea viscosa) also at SW corner.

‘A‘ali‘i
(Dodonaea viscosa)

‘A‘ali‘i *(Dodonaea viscosa)* is a pantropical member of a species complex centered in Australia. The species is extremely variable in leaf and other characters with a complex breeding system and has caused some botanical taxonomic confusion, various species being recognized by different authors (Wagner 1999).

The species forms a common component of dry forest and shrubland in West Hawai‘i.

The fruit and leaves of ‘a‘ali‘i are important in lei making.

A blight is attacking some plants in Hawai‘i.

Figure 32. Locations of field samples with ‘A‘ali‘i *(Dodonaea viscosa).*

Alahe'e
(Psydrax odorata)

Alahe'e forms shrubs or small trees in dry to mesic forest. It can easily be distinguished in the field by its glossy green leaves and black fruits. The old Latin name is *Canthium*.

Alahe'e is abundant and widespread on the Ho'omalu Ka'ū property. The field surveys found many seedlings and mid-size plants of alahe'e on the property, indicating the species may be increasing in abundance on the site.

The wood of alahe'e is very hard and durable and "was used for tools to till the soil and for adze blades for cutting softer wood..." (Wagner, et al. 1999). The leaves produce a dye.

Figure 33. Locations of field samples with Alahe'e *(Psydrax odorata).*

Figure 34. Alahe‘e *(Canthium odoratum).* Alahe‘e is also called *Psydrax odorata.* The photo shows trees of alahe‘e and hundreds of seedlings carpeting the ground underneath.

Figure 35. Hō‘awa *(Pittosporum hosmeri)* flowering in the hō‘awa area.

Hō‘awa
(Pittosporum hosmeri)

Hō‘awa *(Pittosporum hosmeri). P. hosmeri* is closely related to *P. hawaiiense*. It differs in having smooth fruits, whereas *P. hawaiiensis* have fruits with wrinkled or furrowed fruits.

Joseph Rock observed in 1913 that the ‘alalā or Hawaiian Crow *(Corvus hawaiiensis)*, now nearly extinct, “pecks open the large woody capsules and feeds on the oily seeds” (Wagner, et al. 1999).

Rock described the *P. hosmeri* in the area of the Ho‘omalu Ka‘ū property as *P. hosmeri* var. *longifolium*. This has now been taxonomically submerged into *P. hosmeri*.

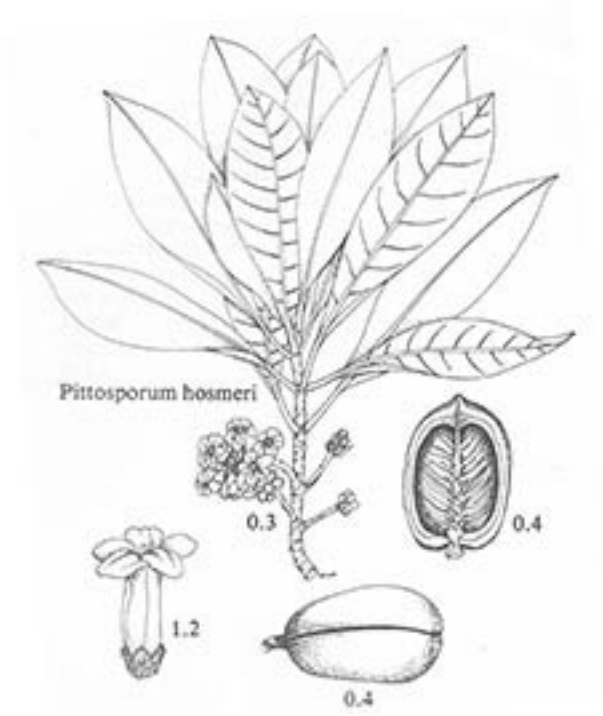


Figure 36. Locations of field samples with hō‘awa *(Pittosporum hosmeri)*.

Huehue
(Cocculus orbiculatus)

Huehue is a common component of dry forests throughout Hawai'i. The vines festoon many of the 'ōhi'a trees on the Ho'omalu Ka'ū property and create a constant hazard of tripping and falling for hikers as a result of catching a foot in the vine.

Huehue is cosmopolitan, occurring from SE Asia to the Himalayas and the Pacific. There is some variation in leaf form and pubescence over the range of the species but different varieties are not recognized taxonomically.

Huehue was sometimes used as cordage.

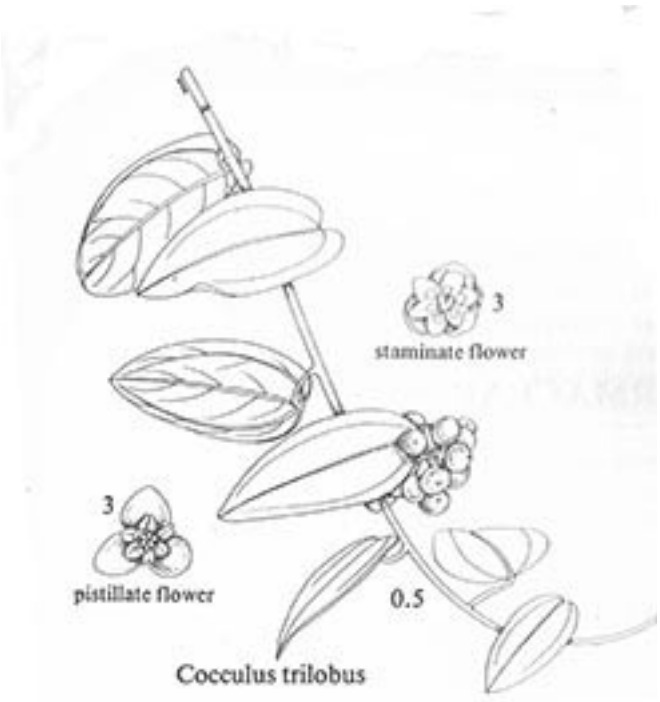


Figure 37. Locations of field samples with Huehue *(Cocculus orbiculatus).*

Figure 38. Huehue (*Cocculus orbiculatus).* Common native vine on the Hoʻomalu Kaʻū property.

Figure 39. Kōlea *(Myrsine lanaiensis).*

Kōlea
(Myrsine lanaiensis)
Kōlea lau nui *(M. lessertiana)*
Kōlea lau li'i *(M. sandwicensis)*

Three species of kōlea were found on the Hoʻomalu Kaʻū property. *Myrsine lanaiensis* was the most commonly encountered species. *M. lessertiana* was far less common, as was *M. sandwicensis*. Both species were found here and there throughout the property with *M. lanaiensis.*

The three species can be distinguished in the field by characteristics of the leaves.

According the Wagner, et al. (1999), kōlea had a number of cultural uses.

Figure 40. Locations of field samples with kōlea ***(Myrsine lanaiensis* -** red), kōlea lau nui ***(M. lessertiana* -** yellow), kōlea lau li'i ***(M. sandwicensis* -** purple).

Kumuniu
(Doryopteris decipiens)

Kumuniu is an uncommon native lava fern in the Cliff Brake Fern family (Pteridaceae) that prefers microsites on otherwise barren lava. It is found in dry shrubland, grassland, or forest, on lava, throughout Hawai'i.

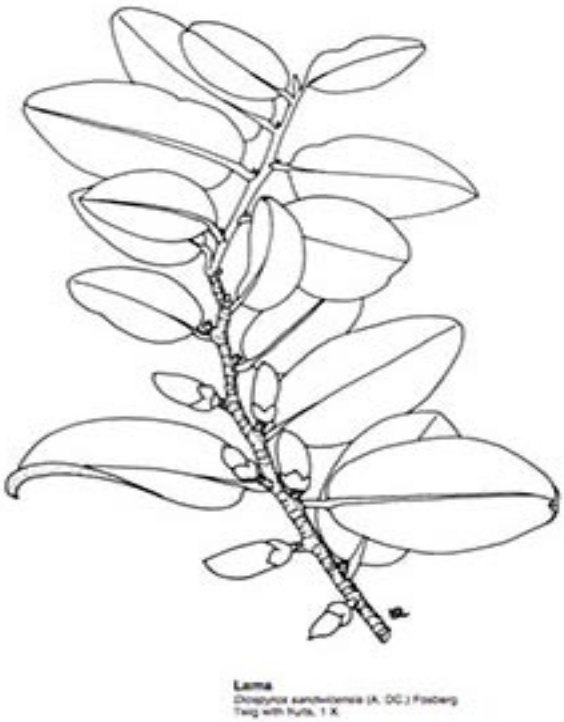
Usually found as diminutive plant with triangular leaf blades, flattened in one plane. The ultimate leaf segments have rounded tips.

Figure 41. Locations of field samples with Kumuniu *(Doryopteris decipiens)*.

Figure 42. Kumuniu *(Doryopteris decipiens)*. Native lava fern.

Figure 43. Lama *(Diospyros sandwicensis)*.

Lama
(Diospyros sandwicensis)



Lama *(Diospyros sandwicensis)* trees were found throughout the Hoʻomalu Kaʻū property, with good examples occurring along the bulldozer trail, hōʻawa area, and southwest corner and west property line. A few trees occur near the ancient trail and along the south fence line.

There is much variation throughout the Pacific in the species complex which *D. sandwicensis* belongs. Wagner treats the Hawaiian species as endemics.

The wood of the species was used in medicine and to fence sacred areas.

Figure 44. Locations of field samples with lama *(Diospyros sandwichensis).*

Maile
(Alyxia stellata)

Formerly *A. oliviformis*, maile is one of the best-known Hawaiian plants, famous for its fragrance and for lei. When left uncut it forms an extensive vine that climbs up into the ʻōhiʻa. The species occurs sporadically on the Hoʻomalu Kaʻū property.

Hawaiians recognize several different kinds of maile, none of which have any currently recognized Latin varietal names. Wagner et al. (1999) list the following: maile haʻi wale, maile lau liʻi, maile lau nui, maile kaluhea, and maile pākaha.

Figure 45. Locations of field samples with maile *(Alyxia stellata).*

Figure 46. Maile *(Alyxia stellata).* Photo courtesy of the Smithsonian.

Figure 47. Māmane *(Sophora chrysophylla)* in central forest area of the Hoʻomalu Kaʻū property.

Māmane
(Sophora chrysophylla)

Māmane (a legume) form shrubs or small trees throughout the Hoʻomalu Kaʻū property. They are particularly abundant in some spots, forming dense thickets.

Evidence of goats grazing the māmane on the property was found in the form of bitten off stems and leaves on some plants. Nevertheless, māmane is reproducing on the property and many seedlings were encountered during the field surveys.

Māmane is the dominant plant in the subalpine vegetation of East Hawai'i and is widespread throughout many habitats.

Figure 48. Locations of sample points with Māmane *(Sophora chrysophylla)*.

Manono
(*Kadua affinis*)

Manono is one of the most highly variable plants in Hawai'i (Wagner, et al. 1999) and many varieties have been described.

The biological basis of this variation is not well understood however, so Wagner, et al. (1999) treat all the related populations as a single species. Manono was formerly known as *Hedyotis terminalis.*

The species occurs uncommonly on the Ho'omalu Ka'ū property and forms small vining shrubs.

Figure 49. Locations of sample points with Manono *(Kadua affinis).*

Figure 50. Manono *(Kadua affinis* a.k.a. *Hedyotis terminalis)* on the Hoʻomalu Kaʻū property.

Figure 51. ʻŌpiko *(Psychotria mauiensis)* on the Hoʻomalu Kaʻū property. This species is doubtfully distinct from kōpiko *(P. hawaiiensis)*.

ʻŌpiko
(*Psychotria mauiensis*)

The "kōpiko" on the Hoʻomalu Kaʻū property may actually be ʻōpiko *(Psychotria mauiensis),* rather than the more commonly known kōpiko *(Psychotria hawaiiensis).* The two species intergrade on Hawai'i Island.

P. hawaiiensis generally has pendant inflorescences on relatively long peduncles whereas *P. mauiensis* has upright inflorescences. All of the *Psychotria* found had upright inflorescences. None were found that were pendant. However, many plants had "domatia", a character of *P. hawaiiensis,* but also of *P. mauiensis.* The plants are not true to type on the Hoʻomalu Kaʻū property. We therefore reserve judgment whether the *Psychotria* found is *P. mauiensis.* Good examples can be seen along the bulldozer trail, in the hōʻawa area, and near the west property line.

Figure 52. Locations of field samples with ʻŌpiko *(Psychotria mauiensis).*

Pilo
(Coprosma menziesii)

Pilo *(Coprosma **menziesii**)* is a many-branched native shrub with opposite leaves. It produces bright orange, globose fruits.

The species was found to be a common component of the vegetation on the Hoʻomalu Kaʻū property. It was regularly encountered throughout the site during the field surveys.

C. menziesii is closely related to the more widespread *C. foliosa* "...and replaces it on the island of Hawai'i" (Wagner, et al.. 1999).

Figure 53. Pilo *(Coprosma menziesii)* occurrences in plots and transects.

Figure 54. Pilo *(Coprosma menziesii).* Photo courtesy of the Smithsonian.

Figure 55. Pūkiawe *(Leptecophylla tameiameiae)* growing next to the ancient trail. Pūkiawe was formerly called *Styphelia tameiameiae.*

Pūkiawe
(Leptecophylla tameiameiae)

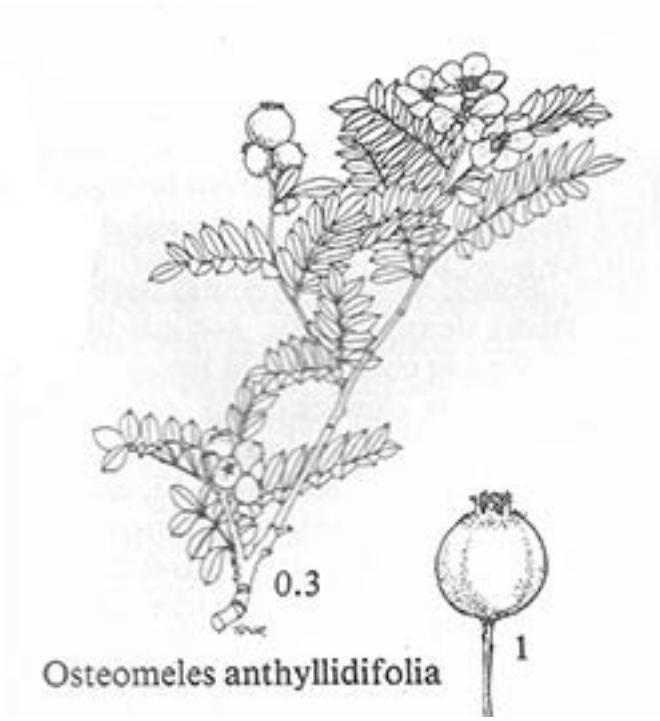
Pūkiawe was formerly called *Styphelia tameiameiae* and many people know it by that name. Recently, plant taxonomists have determined that the species should be placed in the genus *Leptecophylla.*

Pūkiawe is highly variable and occurs over wide areas in many different types of habitats, in Hawai'i and the Marquesas Islands (Wagner, et al. 1999).

Pūkiawe is often used in lei. According to Wagner et al., it was also used as a smudge.

Figure 56. Sample points with pūkiawe *(Leptecophylla tameiameiae).*

ʻŪlei
(Osteomeles anthyllidifolia)



ʻŪlei occurs as a large shrub at many places on the Hoʻomalu Kaʻū property. A member of the rose family, it can easily be recognized by its white flowers.

The species is found in the Cook Islands, Tonga, and Hawaiʻi in a wide variety of habitats (Wagner, et al. 1999). The plant is known to respond positively to disturbance.

ʻŪlei has many Hawaiian cultural uses including numerous items made from the hard wood, and hoops for fish nets made from the slender branches (Wagner, et al. 1999)

Figure 57. Sample points with ʻūlei *(Osteomeles anthyllidifolia).*

Figure 58. ʻŪlei *(Osteomeles anthyllidifolia).* Photo courtesy the Smithsonian.

Discussion

The forest on the Hoʻomalu Kaʻū property is ʻōhiʻa dry forest with significant populations of many native Hawaiian plants. Field surveys reported here documented the occurrence of native plants over the property. The surveys also attempted to identify botanically interesting parts of the property. No federal or state listed endangered or threatened species were found during the surveys. One "species of concern" was found *(Fimbristylus hawaiiensis).*

Despite significant ʻōhiʻa die-back in some parts of the Hoʻomalu Kaʻū property, the forest supports numerous indigenous and endemic native Hawaiian plant species. ʻŌhʻa die-back on the property may be related to long-term drought (Figure 4). Over the last seven years the authors have observed an increase in die-back and a reduction in canopy cover in the ʻōhiʻa forest along the Kāheawai Trail on the west side of the Hoʻomalu Kaʻū property. That the general area is drier now than in the past is also evidenced by large areas on the Hoʻomalu Kaʻū property occupied by native shrubs characteristic of dry sites. The presence of dead tree ferns found during the present survey also indicates drying climate.

ʻŌhiʻa are not regenerating at present on the Hoʻomalu Kaʻū property. Although the ʻōhiʻa trees are making seed, no seedlings of ʻōhiʻa were found anywhere on the property. Other native plants on the property <u>are</u> producing numerous seedlings, possibly indicating that those species are increasing while ʻōhiʻa is declining.

Alaheʻe, for example, is an indigenous native plant that responds to disturbance. It is often found forming thickets on old abandoned sweet-potato farms in Kona, where it aggressively took over many acres before alien species were introduced. Something similar could be happening on the Hoʻomalu Kaʻū property as the ʻōhiʻa canopy cover has been declining and the endemic moist-site species are gradually replaced by more drought and disturbance tolerant indigenous ones.

The Hoʻomalu Kaʻū property is an excellent example of ʻōhiʻa dry forest. Field surveys reported here show that the forest on the property is virtually weed free and provides habitat for many important native plant species. In spite of long-term drought and a relatively recent increase in ʻōhiʻa die-back the forest on the property remains good habitat. Conservation of this tract of forest will add more preserved forest land adjacent to Manukā Natural Area Reserve.

Recommendations

To maintain and preserve the existing forest resource the property will need to be fenced to prevent future increased grazing by goats, sheep, and pigs. Since a fence already occurs on the east boundary and Manukā Natural Area Reserve is planned to be fenced, only the upper and lower property lines would need fencing. More plants, both native and alien may appear once the property is fenced. It should be noted however, that goats have been known to climb over fences, and wild turkeys can fly in so exclusion of animals is never 100%.

Development of the ancient/historic trail into a nature trail has been proposed. The trail could be reached from the building site area over the lava flow in the northeast corner, continue west and connect to a short side trail to the hōʻawa area, which could continue to the highway.

For a longer hike, visitors could continue west on the ancient trail to its intersection with the bulldozer track on the west boundary. The hōʻawa area and the portion of the ancient trail near the bulldozer track are good places for viewing many of the native plants on the property.

Not only would the trail have to be considerably improved for safe use by the public, there would also have to be some kind of protection of the more valuable plants along the trail. Signage would be needed to provide plant names and cultural uses of various species. In addition, any public facility would need some kind of security.

The actual design of the trail and the placement of plants and signage are subjects for a detailed landscape design and will require further study. We encourage Hoʻomalu Kaʻū to continue to develop the idea of a nature trail and explore various design options.

In the future, rare and interesting Hawaiian plants could be propagated and planted along the nature trail. Propagation of listed species would require cooperative agreements with the State of Hawaiʻi and U.S. Fish and Wildlife. Horticultural expertise would also be needed because many of the rarest plants have specific habitat requirements.

A propagation facility would require greenhouses and shade houses and would require an investment in tanks for large quantities of water storage. The size of the facility would ultimately be limited by a lack of public water supply in the area.

We recommend that Hoʻomalu Kaʻū continue exploring the forest on the property on a regular basis. Different species may appear at different times or in different years, so any survey can only be a snapshot in time. The species list for the property should be considered a data base that will expand as more species are added in the future. We encourage others to add to this species list. Over time, additional species will undoubtedly be found.

Studies of any tract of native Hawaiian forest bring up an almost infinite array of natural history questions for the future. We highly recommend that other biologists that are expert in birds, insects, and other fields be encouraged to study this area. We also recommend that a summary of cultural uses of the native species on the property be compiled.

Table I. Plant species by plot. Figures are cover/abundance (Domin Scale).

Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	C
Ageratina riparia	p			p																						2
Ageratum houstonianum						p																				1
Alyxia stellata													1	p		p										3
Andropogon virginicus	p																	p		p						3
Antidesma platyphyllum														p												1
Carex wahuensis ssp. rub.	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p	p	1	p		p	p	p	23
Chrysopogon aciculatus				p																						1
Cladonia rangiferina			p												p			1								3
Cocculus orbiculatus	1	1	1		p	1	1	1	1	1	1	1		2	1	1	p	p	p	1				1	1	20
Conyzia bonariensis											p															1
Coprosma menziesii	p	p				2	p		p		p		p	2	2	2									1	11
Coprosma menziesii				1	1			2																		3
Coprosma montana CF			2																							1
Cyperus hillebrandii							p r																			1
Dianella sandwicensis				p																						1
Diospyros sandwicensis					p					p	2		2	p	p		1						p			8
Dodonaea viscosa	2	2s	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	2	2		2	2	2	24
Doryopteris decipiens			p r	p	p	p r	p	p						p	p	p										9
Gomphocarpus physo.			p																							1
Hedyotis terminalis.			p			p	p							3		p										5
Hyptis pectinata	p		p								p	p		p												5
Kalanchoe pinatta																		p								1
Korthalsella rernyana		p		p												p r										3
Lepisorus thungbergianus.	p		p	p	p		p				p		p	p												8
Leptecophylla tameiameiae	2	2				1		1	2	2		2	1	1	2	2	1	2	1	2	2		3	2	2	19
M. p. var. glaberrima	p	p	p	p				p	p					p												7
M. p. var. incanum	p	p							p	p				p												5
Mariscus hillebrandii	p	p	p		p	p			p		p	p	p	p	p	p	p	p	p	p	p			p	p	19
Melinis minutiflora						p						p														2
Metrosideros poly var. poly	5	4	4	4	4	4	4	4	4	3	3	4	4	4	3	4	4	3	3	4	4		3	3	4	24
Myrsine lanaiensis	2	2s	2		1				2	1	1	1	1	p		p	1	p						p	1	15
Myrsine lessertiana						p							1													2
Myrsine sandwicensis					p					p				p									p			4
Nephrolepis brownii																							p	p		2
Nephrolepis brownii	1	p	p	1	p	p	p		p	p	p	p		p	p	p		p		p	p				p	18
Oplismenus hirtellus											p	p														2
Osteomeles anthyllidifolia	2	2				2	2	1	2	2	2	3	2	2	2	1	2	2	3	2	2		3	2	2	21
Passiflora suberosa											p															1
Pellaea ternifolia				p	p	p								p												4
Pennisetum setaceum	p											p														2
Peperomia blanda	p			p	p	p	p				p	p		p		p										9
Persicaria capitata											p															1
Pipturus albidus														4												1
Pittosporum hosmeri							p	1						2												3
Plectranthus parviflorus			p												p	p										3
Pluchea carolinensis					p						p			p				p								4
Polytrichum juniperinum			p	p																						2
Portulaca pilosa					p													p								2
Psilotum nudom	p	1	p	p		p	p				p			p	p	p				p						11
Psychotria hawaiiensis	p												p													2
Psychotria mauiensis	p		p									p	p	p		p										6
Psydrax odorata	2	2sn	2s			1	1	1	2	1	2	1	2	2	1	2	2	1	1	p	1		1	1	2	22
Rhynchelytrum repens											p	p		p			p	p		p			p	p	p	9
Schizachyrium condensatum	p																p				p		p	p		5
Sophora chrysophylla	1			p	1					1	2	2	2		p	p	1	p	3		2		1	1	1	16
Vaccinium dentatum									p																	1
Wikstroemia phillyreifolia	1				p	p	1	1	1	1	p	1		1	1	1		1		1			p	1	1	17
																										0

Table II. Plots with species ordered according to Constancy (C).

Species	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	C
Dodonaea viscosa	2	2s	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	2	2		2	2	2	24
Metrosideros poly var. poly	5	4	4	4	4	4	4	4	4	3	3	4	4	4	3	4	4	3	3	4	4		3	3	4	24
Carex wahuensis ssp. rub.	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p	p	1	p		p	p	p	23
Psydrax odorata	2	2sn	2s			1	1	1	2	1	2	1	2	2	1	2	2	1	1	p	1		1	1	2	22
Osteomeles anthyllidifolia	2	2				2	2	1	2	2	2	3	2	2	2	1	2	2	3	2	2		3	2	2	21
Cocculus orbiculatus	1	1	1		p	1	1	1	1	1	1	1		2	1	1	p	p	p	1				1	1	20
Mariscus hillebrandii	p	p	p		p	p			p		p	p	p	p	p	p	p	p	p	p	p			p	p	19
Leptecophylla tameiameiae	2	2				1		1	2	2		2	1	1	2	2	1	2	1	2	2		3	2	2	19
Nephrolepis brownii	1	p	p	1	p	p	p		p	p	p	p		p	p	p		p		p	p				p	18
Wikstroemia phillyreifolia	1				p	p	1	1	1	1	p	1		1	1	1		1		1			p	1	1	17
Sophora chrysophylla	1			p	1					1	2	2	2		p	p	1	p	3		2		1	1	1	16
Myrsine lanaiensis	2	2s	2		1				2	1	1	1	1	p		p	1	p						p	1	15
Coprosma menziesii	p	p				2	p		p		p		p	2	2	2									1	11
Psilotum nudom	p	1	p	p		p	p				p			p	p	p				p						11
Doryopteris decipiens			p	r p	p	p	r p	p						p	p	p										9
Peperomia blanda	p			p	p	p	p				p	p		p		p										9
Rhynchelytrum repens											p	p		p			p	p		p			p	p	p	9
Diospyros sandwicensis					p					p	2		2	p	p		1						p			8
Lepisorus thungbergianus.	p		p	p	p		p				p		p	p												8
M. p. var. glaberrima	p	p	p	p				p	p					p												7
Psychotria mauiensis	p		p									p	p	p		p										6
Hedyotis terminalis.			p			p	p							3		p										5
Hyptis pectinata	p		p								p	p		p												5
M. p. var. incanum	p	p							p	p				p												5
Schizachyrium condensatun	p																p				p		p	p		5
Myrsine sandwicensis					p					p				p									p			4
Pellaea ternifolia				p	p	p								p												4
Pluchea carolinensis					p						p			p				p								4
Alyxia stellata													1	p		p										3
Andropogon virginicus	p																	p		p						3
Cladonia rangiferina			p												p			1								3
Coprosma menziesii				1	1			2																		3
Korthalsella rernyana		p		p												p r										3
Pittosporum hosmeri							p	1						2												3
Plectranthus parviflorus			p												p	p										3
Ageratina riparia	p			p																						2
Polytrichum juniperinum			p	p																						2
Melinis minutiflora						p						p														2
Myrsine lessertiana						p							1													2
Nephrolepis brownii																							p	p		2
Oplismenus hirtellus											p	p														2
Pennisetum setaceum	p											p														2
Portulaca pilosa					p													p								2
Psychotria hawaiiensis	p												p													2
Ageratum houstonianum						p																				1
Chrysopogon aciculatus				p																						1
Conyzia bonariensis											p															1
Coprosma montana CF			2																							1
Cyperus hillebrandii							p r																			1
Dianella sandwicensis				p																						1
Gomphocarpus physo.			p																							1
Kalanchoe pinatta																		p								1
Passiflora suberosa											p															1
Persicaria capitata											p															1
Pipturus albidus														4												1
Antidesma platyphyllum														p												1
Vaccinium dentatum									p																	1
																										0

Appendix

Plant Species
and
Animal Species
Encountered During
Field Surveys of Hoʻomalu Kaʻū Property
February and March 2014

Palmer & Associates Consulting
P. O. Box 637
Pahoa, Hawaiʻi 96778

Plant Species Encountered
on the
HOʻOMALU KAʻŪ
Property
(February and March, 2014)

FAMILY Genus / species	Hawaiian/Common Name	Distribution
PTERIDOPHYTES (Ferns and Fern Allies)		
ASPLENIACEAE	Spleenwort Fern Family	
Asplenium adiantum-nigrum L.	ʻiwaʻiwa	I
Asplenium trichomanes subsp. densum (Brack.) W.H. Wagner	ʻoaliʻi	E
BLECHNACEAE	Blechnum Fern Family	
[2]*Sadleria cyatheoides* Koulf.	ʻamaʻu	E
DOCLSPMOACEAE	Tree Ferm Family	
[2]*Cibotium glaucum* (sm.) Hook. & Arn.	hāpuʻu	E
NEPHROLEPIDACEAE	Sword Fern Family	
Nephrolepis brownii (Desv.) Hovenk. & Miyam.	sword fern	A
POLYPODIACEAE	Common Fern Family	
Lepisorus thunbergianus (Kaulf.) Ching	pakahakaha	I
Phymatosorus grossus (Langsd. & Fisch.) Brownlie	laua'e	A
PSILOTACEAE	Whisk Fern Family	
Psilotum nudum (L.) P. Beauv.	moa	I
PTERIDACEAE	Cliff Brake Fern Family	
Adiantum hispidulum sw.	five-finger maidenhair	A
Doryopteris decipiens (Hook.) J. Sm.	kumuniu	E
Pellaea ternifolia (Cav.) Link	ladder brake	I

ANGIOSPERMS (FLOWERING PLANTS)

DICOTYLEDONS

ANACARDIACEAE	Mango Family	
Schinus terebinthifolius Raddi	Christmas berry	A
APOCYNACEAE	Dogbane Family	
[2]*Alyxia stellata* (J.R. Forst. & G. Forst.) Roem. & Schult.	maile	I
Calotropis procera (Aiton) Dryand.	crownflower	A
Gomphocarpus physocarpus E. Mey	balloon plant	A
ASTERACEAE	Sunflower Family	
Ageratina riparia (Regel) R.M. King & H. Rob.	pamakani	A
Ageratum houstonianum Mill.	maile hohono	A
Bidens pilosa L.	ki nehe / Spanish needles	A
Crassocephalum crepidioides (Benth.) S. Moore	red flower ragleaf	A
Emilia fosbergii Nicolson	Flora's paintbrush	A
Erectites hieraciifolius (L.) Raf. ex DC	fireweed	A
Erigeron bonariensis L.	hairy horseweed	A
Erigeron canadensis L.	horseweed	A
Gnaphalium purpureum L.	purple cudweed	A
Pluchea carolinensis (Jacq.) G. Don	sourbush	A
Sonchus oleraceus L.	pualele / sow thistle	A
BIGNONIACEAE	Bignonia Family	
Jacaranda mimosifolia D. Don	jacaranda	A
CHENOPODIACEAE	Goosefoot Family	
Dysphania carinata (R.Br.) Mosyakin & Clemants	creeping goosefoot	A
CRASSULACEAE	Jade Tree Family	
Kalanchoe delagoensis Eckl. & Zeyh.	chandelier plant	A
Kalanchoe pinnata (Lam.) Pers.	air plant	A
EBENACEAE	Ebony Family	
[2]*Diospyros sandwicensis* (A. DC) Fosb.	lama	E

ERICACEAE	Health Family	
[2]*Leptecophylla tameiameiae* (Charm. & (Schlechtend.) C. M. Weiller	pūkiawe	I
[2]*Vaccinium dentatum* Sm.	ʻōhelo	E
EUPHORBIACEAE	Spurge Family	
Euphorbia hirta L.	garden spurge	A
Euphorbia hypericifolia L.	graceful spurge	A
cf. *Euphorbia sp*.	heart-leaf Euphorbia	A
Manihot carthaginensis subsp. *glaziovii* Mull. Arg.	Ceara rubber tree	A
Ricinus communis L.	castor bean	A
FABACEAE	Bean Family	
Chamaecrista nictitans (L.) Moench	partridge pea	A
Crotalaria pallida Aiton	rattlepod	A
Desmodium incanum DC	Spanish clover	A
Desmodium tortuosum (Sw.) DC	Florida beggarweed	A
Desmodium triflorum (L.) DC	begger's tick	A
Indigofera suffruticosa Mill.	indigo	A
Leucaena leucocephala (Lam.) de Wit	haole koa	A
Macroptilium lathyroides (L.) Urb.	cow pea	A
Neonotonia wightii (Wight & Arn.)	Lackey perennial soybean	A
[2]*Sophora chrysophylla* (Salisb.) Seem.	māmane	E
LAMIACEAE	Mint Family	
Hyptis pectinata (L.) Poit.	comb hyptis	A
Plectranthus parviflorus Willd.	ʻalaʻala wai nui pua kī	I
MALVACEAE	Mallow Family	
Abutilon grandifolium (Willd.) Sweet	false ʻilima	A
Malvastrum coromandelianum subsp. *coromandelianum* (L.) Garcke	false mallow	A
Sida rhombifolia L.	arrow leaf sida	A
Waltheria indica L.	ʻuhaloa	I
MENISPERMACEAE	Moonseed Family	
Cocculus orbiculatus (L.) DC	huehue	I
MYRTACEAE	Myrtle Family	
[2]*Metrosideros polymorpha* var. *polymorpha* Gaud. var. *glaberrima* (H. lev.) St. John var. *incana* (H. lev.) St. John	ʻōhiʻa	E
Psidium cattleianum Afzel. ex Sabine	strawberry guava	A
Psidium guajava L.	guava	A

PASSIFLORACEAE	Passion Flower Family	
Passiflora suberosa L.	huehue haole	A
PHYLLANTHACEAE	Leafflower Family	
[2]*Antidesma platyphyllum* H. Mann	mehame	E
Phyllanthus tenellus Roxb.	leafflower	A
PIPERACEAE	Pepper Family	
[2]*Peperomia blanda* (Jacq.) Kunth	ʻalaʻala wai nui	I
PITTOSPORACEAE	Pittosporum Family	
[2]*Pittosporum hosmeri* Rock	hōʻawa	E
POLYGONACEAE	Buckwheat Family	
Persicaria capitata (Buch.-Ham. ex D. Don) H. Grass	pinkhead smartweed	A
PORTULACACEAE	Purslane Family	
Portulaca grandiflora Hook.	moss-rose	A
Portulaca pilosa L.	hairy portulaca	A
PRIMULACEAE	Primrose Family	
Myrsine lanaiensis Hillebr.	kōlea	E
[2]*Myrsine lessertiana* A. DC	kōlea lau nui	E
[2]*Myrsine sandwicensis* A. DC	kōlea lau liʻi	E
PROTEACEAE	Protea Family	
Grevillea robusta A. Cunn. ex R. Br.	silk oak	A
ROSACEAE	Rose Family	
[2]*Osteomeles anthyllidifolia* (Sm.) Lindl.	ʻūlei	I
RUBIACEAE	Coffee Family	
[2]*Coprosma menziesii* A. Gray	pilo	E
[2]*Kadua affinis* DC. (synonym: *Hedyotis terminalis* (Hook. & Arnott) W. L. Wagner & Herbst)	manono	E
Oldenlandia corymbosa L.	diamond flower	A
[2]*Psychotria mauiensis* Fosb.	ʻōpiko	E
or cf. *P. hawaiiensis*(A. Gray) Fosb .	kōpiko	E
[2]*Psydrax odorata* (G. Forst.) A.C. Sm. & S.P. Darwin	alaheʻe	I
Richardia brasiliensis Gomes	Mexican clover	A
SAPINDACEAE	Soapberry Family	
[2]*Dodonaea viscosa* Jacq.	ʻaʻaliʻi	I

SOLANACEAE	Nightshade Family	
Solanum americanum Mill.	pōpolo	I
THYMELACEAE	ʻĀkia Family	
[2]*Wikstroemia phillyreifolia* A. Gray	ʻākia	E
URTICACEAE	Nettles Family	
[2]*Pipturus albidus* (Hook. & Arn.) Gray ex H. Mann.	māmaki	E
VERBENACEAE	Vervain Family	
Stachytarpheta urticifolia (Salisb.) Sims	nettle leaf vervain	A
VISCACEAE	Mistletoe Family	
Korthalsella remyana Tiegh.	hulumoa	E

MONOCOTYLEDONS

ASPARAGACEAE	Asparagus Family	
Asparagus macowanii Baker	regal-fern	A
Furcraea foetida (L.) Haw.	Mauritius hemp	A
CYPERACEAE	Sedge Family	
[2]*Carex wahuensis* subsp. *rubiginosa* (R. Krauss) T. Koyama	Hawaiian Carex	E
Cyperus hillebrandii var. *hillebrandii* Boeck.	Hillebrand's flatsedge	E
[1]*Fimbristylis hawaiiensis* Hillebr.	fimbry	E
Pycreus polystacyos (Rottb.) P. Beauv.	pycreus	I
ORCHIDACEAE	Orchid Family	
Arundina graminifolia (D. Don) Hochr.	bamboo orchid	A
POACEAE	Grass Family	
Aira caryophyllea L.	silver hairgrass	A
Andropogon virginicus L.	yellow bluestem	A
Chloris divaricata R. Br.	stargrass	A
Chrysopogon aciculatus (Retz.) Trin.	mānienie	I
Coix lachryma-jobi L.	Job's tears	A
Eleusine indica (L.) Gaertn.	wiregrass	A
Festuca rubra L.	red fescue	A
Hyparrhenia rufa (Nees) Stapf.	thatching grass	A
Melinis minutiflora P. Beauv.	molasses grass	A
Oplismenus hirtellus P. Beauv.	basket grass	A
Panicum maximum Jacq.	Guinea grass	A

Pennisetum clandestinum Hochst. ex Chiov.	kikuyu grass	A
Pennisetum setaceum (Forssk.) Chiov.	fountain grass	A
Rhynchelytrum repens (Willd.) Hubb.	Natal redtop	A
Schizachyrium condensatum (Kunth) Nees	beard grass	A
XANTHORRHOEACEAE	Grass Tree Family	
[2]*Dianella sandwicensis* Hook. & Arn.	ʻukiʻuki	I

BRYOPHYTES

(Mosses - incomplete list)

POLYTRICACEAE	Haircap Moss Family	
Polytricum juniperinum Hedwig	juniper haircap moss	I

FUNGI

BASIDIOMYCOTA
(Mushrooms)

AMANITACEAE	Fly Aragie Mushroom Family	
Amanita marmorata Cleland & E.J. Gilbert	deathcap	A
MARASMIACEAE	Marasmia Mushroom Family	
Gymnopus subpruinosus (Murrill) Desjardin, Halling, & Hemmes	toughshank	A
POLYPORACEAE	Polypore Mushroom Family	
Polyporus arcularius (Batsch) Fr.	Spring polypore	A

ASCOMYCOTA
(Sac Fungi & Lichen)

CLADONIACEAE	Reindeer Lichen Family	
Cladonia cristatella Tuck.	British soldier	I
Cladonia rangiferina (L.) Weber ex F.H. Wigg.	reindeer lichen	I
PARMELIACEAE	Rock Lichen Family	
CF *Xanthoparmelia lavicola* (Gyeln.) Hale	rock lichen	A
XYLARIACEAE	Carbon Rod Fungi Family	
Xylaria sp. (Tul. & C. Tul.)	carbon rod	A

ANIMALS ENCOUNTERED DURING THE FIELD SURVEYS

CHORDATA

Mammals

BOVIDAE	Bovine Family	
Capra hircus (Linnaeus, 1758)	feral goat	A
Ovis aries (Linnaeus, 1758)	mouflon sheep	A
SUIDAE	Pig Family	
Sus scrofa (Linnaeus, 1758)	feral pig	A

Reptiles

CHAMAELEONIDAE	Chameleon Family	
Trioceros jacksonii (Boulenger, 1896)	Jackson's chameleon	A
SCINCIDAE	Skink Family	
Niveoscincus metallicus (O'shaughnessy, 1874)	metallic skink	A

Avian List

GALLIFORMES

PHASIANIDAE	Pheasant Family	
Meleagris gallopova (Linnaeus, 1766)	Wild Turkey	A

PASSERIFORMES

CARDINALIDAE	Cardinal Family	
Cardinalis cardinalis (Linnaeus, 1758)	Northern Cardinal	A
COLUMBIDAE	Dove Family	
Geopelia striata (Linnaeus, 1766)	Zebra Dove	A
Streptopelia chinensis (Scopoli, 1786)	Spotted Dove	A
EMBERIZIDAE	American Sparrow Family	
Paroaria capitata (Orbigny & Lafresnaye, 1837)	Yellow-billed Cardinal	A
Sicalis flaveola (Linnaeus, 1766)	Saffron Finch	A
ESTRILDIDAE	Waxbill Family	
Lonchura punctulata (Linnaeus, 1758)	Nutmeg Mannikin	A

FRINGILLIDAE	Finch Family	
Carpodacus mexicanus (Statius Muller, 1776)	House Finch	A
Himatione sanguinea (Gmelin, 1788)	‘Apapane	E
Serinus mozambicus (Statius Muller, 1776)	Yellow-fronted Canary	A
STURNIDAE	Starling Family	
Acridotheres tristis (Linnaeus, 1766)	Mynah	A
ZOSTEROPIDAE	White-eye Family	
Zosterops japonicus (Temminck & Schlegel, 1847)	Japanese White-eye	A

ARTHROPODA

Insects

AESHNIDAE	Giant Dragonfly Family	
[2]*Anax strenuus* (Hagen, 1867)	pinao	E
CULICIDAE	Mosquito Family	
Aedes albopictus (Skuse, 1894)	forest mosquito	A
CURCULIONIDAE	Weevil Family	
Xylosandrus compactus (Wood & Bright, 1992)	black twig borer	A
FANNIIDAE	House Fly Family	
Fannia sp. (Robineau-Desvoidy, 1830)	small house fly	A
FORMICIDAE	Ant Family	
Ochetellus glaber (Mayr, 1862)	black house ant	A
LIBELLULIDAE	Skimmer Dragonfly Family	
Crocothemis servilia (Drury, 1773)	Chinese dragonfly	A
LYCAENIDAE	Gossamer-Wing Butterfly Family	
Strymon bazochii (Godart, 1824)	small lantana butterfly	A
NOCTUIDAE	Owlet Moth Family	
Ascalapha odorata (Linnaeus, 1758)	black witch moth	A
NYMPHALIDAE	Milkweed Butterfly Family	
Danaus plexippus (Linnaeus, 1758)	monarch butterfly	A

Arachnids

ARANEIDAE	Orb-Web Spider Family	
Gasteracantha mammosa (C.L. Koch, 1844)	Asian spiny-backed spider	A

Key

E = Endemic; occurring only in Hawai‘i.
I = Indigenous; native to Hawai‘i and elsewhere.
P = Polynesian; introduced to Hawai‘i prior to 1778.
A = Alien; introduced to Hawai‘i after 1778.

[1]U. S. Fish and Wildlife Service “Species of Concern”

[2]State of Hawai‘i “species of greatest conservation need”

Addendum: We include here three plants, now possibly extirpated from the Ho‘omalu Ka‘ū property, listed by Rick Warshaur in March 2013. The dead kauila *(Alphitonia ponderosa)* was mentioned previously. Two other plants on his list were alani (*Pelea* cf. *spp*., pos. *P. clusiifolia?*) and ‘iliahi (*Santalum* cf. *spp.,* pos. *paniculatum?).*

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