
Lands of Kalulu and Kaunolu, Lahaina District, Lāna'i Island, TMK: (2) 4-9-002:061

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Management Summary

Contents
1 Introduction 2
3 Research Objectives 5
4 Data Needs, Methods, and Curation 7
Glossary 8

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Figure 1: Location of Sites 50-40-98-1980 and 50-40-98-1981 and the Miki Basin 200 Acre Industrial Development on a USGS quadrangle map.

Site 50-40-98-1980 is located in the northernmost portion of the project area in a highly eroded area along the fence line boundary with the Lita'si Airport (fig. 1). The site comprises two components, a lithic scatter and an eroded and exposed fire-pit.

The lithic scatter is located on the crest of a slope and extends south along a drainage cut. The scatter covered an area of approximately 30 x 120 m (meter) and, at the time of survey, contained 30 or more pieces of flaked basalt. All of the artifacts that were observed and collected from the scatter came from within or adjacent to the existing drainage in areas that lacked vegetation. A cowry shell fragment and several pieces of branch coral were observed within the scatter. Three adze rejects, a hammerstone, a waterworn pebble manuport, and a piece of branch coral were collected from the scatter (fig. 2). No artifacts were observed or collected in the vegetated areas around the drainage. This suggests that the artifacts have either moved downslope from a higher location as a result of water erosion or that the site has eroded and deflated over time. In either case, the artifacts would have been secondary deposited from their original position.

The second component of Site 50-40-98-1980 was an exposed fire-pit remnant located within the lithic scatter on the crest of the slope in a heavily eroded area. The fire-pit remnant was observed over an approximately 75 cm (centimeter) diameter area and had exposed charcoal and a few small cobble-size fire-affected rocks on the surface and eroding downslope. No black plastic or tubing was observed in or around the fire-pit because the plow zone in this location had completely eroded away. It is likely that the fire-pit had originally been truncated by plows when the pineapple field was cultivated. Following documentation of the fire-pit remnant, the fire-pit was bisected twice to determine its size and stratigraphic position (fig. 3).

![Figure 3: Sketch map and cross section drawing of a subsurface fire-pit recorded at Site 50-40-98-1980.](image)

The first bisection point, A to A', cut the fire-pit in half to expose the stratigraphic section. Following bisection, a 15 cm deep profile was exposed. Context 16, a loose red silty clay loam sediment, was present from the current ground surface to a depth of 3 cm. It appears that the sediment has been deposited over the fire-pit due to water erosion along the drainage. The fire-pit, Context 15, is a band of charcoal that extends from 3 cm below surface to a depth of 12 cm. The fire-pit at this location is approximately 60 cm wide and is basin shaped. The interface between the Context 15 fire-pit and the material it had been dug into, the Context 2 dark reddish brown silty clay loam hard pan soil, was recorded as Context 17. The Context 2 soil was present to the base of excavation at 15 cm below surface.
The second bisection point, B to B', was cut just in front of the two rocks that were exposed on the surface. Following bisection, a 20 cm deep profile was exposed. Context 15, a loose red silty clay loam sediment, was present from the current ground surface to a depth of 6 cm. The sediment has been deposited over the fire-pit due to water erosion along the drainage. The fire-pit, Context 15, is a curved band of charcoal that extends from 6 cm below surface to a maximum depth of 15 cm. The fire-pit at this location is approximately 75 cm wide and is basin shaped. The interface between the Context 15 fire-pit and the material it had been dug into, the Context 2 dark reddish brown silty clay loam hard pan soil, was recorded as Context 17. The Context 2 soil was present to the base of excavation at 20 cm below surface. A charcoal sample was collected from each profile after bisection for wood taxa identification and ¹⁴C analysis.

A subsurface cultural deposit recorded as Site 50-40-98-1981 was identified in a backhoe trench (see fig. 1, p. 2). The deposit was a truncated fire-pit remnant exposed in the southern profile of the backhoe trench (fig. 4). The fire-pit was truncated by the plow zone layer, Context 1, present to a depth of 35 cm below surface. The upper portion of the fire-pit appears to have been destroyed by a plow moving east to west; charcoal from the fire-pit is scattered an additional 65 cm to the west within the plow zone. The fire-pit remnant is approximately 65 cm in width, approximately 10 cm thick, basin shaped, and is present between 35 and 45 cm below surface. A single rounded volcanic cobble was observed within the feature. The fire-pit had been excavated into Context 2, a dark reddish brown silty clay hardpan soil present to a depth of 100 cm below surface. The interface between the fire-pit and the Context 2 soil it had been excavated into was recorded as Context 13. Context 2 overlay Context 9, a dark brown silty clay loam present to the base of excavation at 150 cm below surface. A charcoal sample was collected from the Context 12 fire-pit for wood taxa and ¹⁴C analysis.

Sites 50-40-98-1980 and 50-40-98-1981 were evaluated as significant for the important information on Hawaiian history and prehistory that they have yielded.

3 Research Objectives

The inventory survey report recommended that a data recovery plan be developed and implemented prior to construction activities at the Miki Basin 200 Acre Industrial Development. It was further recommended that the data recovery plan develop research questions that can be addressed with data yielded by the following laboratory tasks:

Site 50-40-98-1980 Analysis of the wood charcoal collected from the Context 15 fire-pit for taxa identification and ¹⁴C dating. Analysis of artifacts collected from the Context 18 lithic scatter to further investigate the tool-making reduction sequence utilized on the island [15].


The research objectives of the proposed data recovery investigations include gathering data on the history of vegetation change on Lāna‘i in an effort to date two periods of change, one during the traditional Hawaiian period and the other in the mid-nineteenth century when sheep and goats were raised on the island [7], and to complete paired technological and geochemical sourcing analyses of the lithic artifacts to determine the reduction sequences for the flaked stone implements, and to determine likely source locations for the fine-grained, tool-grade basalt items in the collection.

The first period of vegetation change that will be investigated involves a process identified as landscape transport [2; 8], whereby the Polynesian settlers of Hawai‘i established about 28 species of plants brought to the islands from a homeland in the southern hemisphere [13:321 ff]. This process has been dated to the mid-fifteenth century on O‘ahu Island [6], but thus far has proved elusive on Lāna‘i, where native plants dominate firewood throughout the traditional Hawaiian sequence. For example, wood charcoal from five taxa introduced by Polynesians, including cf. kou, 'ulu, kukui, 'ōhi‘a 'ai and ʻohi‘a 'ai was recovered in small amounts (generally less than 1% by weight) in all of the charcoal collections from two sites at the coastal settlement in Kaunolu [1]. Based on the available dating evidence, the charcoal collections at Kaunolu date to late in the traditional Hawaiian sequence and to the early historic period. The lowland native forest at Kaunolu appears to have persisted into the early historic period. Similarly, several collections of firewood charcoal from Hulopoe insecurly dated to the period AD 1300-1850 were composed...
primarily of native woods, with trace occurrences of 'ulu and kō [10]. Two fire-pits dated to around the early historic period on the coast at Mānāle [5] were fueled almost entirely with native species, and a somewhat earlier fire-pit located inland near Lānai City [4] also yielded predominantly native firewood.

The second period of vegetation change in the mid-nineteenth century involves the nearly complete collapse of the native lowland dry forest with the introduction of grazing herbivores [5]. To date, fire-pits from this recent period have not been identified and investigated on Lānai.

The research objective for the stone artifacts is to characterize the chaine opératoire for the tools fashioned from fine-grained basalt. An attempt will be made to identify the source of the rock with non-destructive geochemical analysis, describe the reduction sequence along the lines set out by Weisler [12], and classify tools according to function [11], as far as possible given the fragmentary materials.

4 Data Needs, Methods, and Curation

The data needed to address the research objectives were collected during the inventory survey and comprise the contents of the two fire-pits and the secondarily deposited stone artifacts collected at Site 50-40-98-1980.

Field methods are not required to acquire and analyze the data because exhaustive field collections were made during the archaeological inventory survey.

The laboratory work needed to carry out the data recovery investigation includes charcoal identification at the Wood Identification Laboratory of International Archaeological Research Institute, accelerator mass spectrometry (AMS) dating of one specimen of short-lived wood charcoal from each of the fire-pits, and calibration of the laboratory results with the BCal software package [5]. Non-destructive geochemical characterization with EDXRF will be carried out at the University of Hawai'i at Hilo [6].

The procedure for depositing collections after the conclusion of the proposed data recovery project involves returning them to Lānai Island, where they will be redeposited at the Lānai Culture and Heritage Center, where they are currently stored.

The plan does not call for additional fieldwork. Thus, we do not anticipate that human burials will be disrupted.

Sites 50-40-98-1980 and 50-40-98-1981 were not determined significant under criterion "e," which pertains to sites that have "an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts of these associations being important to the group's history and cultural identity" (§13-275-6(b)(5)). Thus, there is no requirement that consultation with members of the relevant ethnic group be undertaken during preparation of this plan.

Glossary

clay Fine earth particles less than 0.002 mm.

cobble Rock fragment ranging from 76 mm to less than 250 mm.

fire-pit A pit of varying depth, often bowl shaped at the base, usually identified by a concentration of charcoal and/or burned material in the fill, especially at the feature interface.

manuport A natural object found in an unnatural position, having been carried there by man.

project The archaeological investigation, including laboratory analyses and report preparation.

Hawaiian Terms

Ipū The gourd, Lagenaria siceraria. 'ulu Sugarcane, Saccharum officinarum, was introduced to Hawai'i by Polynesian settlers, who cultivated it widely. The stalk was chewed between meals for its sweetness, brought on long journeys to ease hunger, and eaten in times of famine; juice from the stalk was fed to nursing babies, and used as a sweetening agent in medicinal herbal concoctions; the leaves were used as thatching for houses; the leaf midrib was used for plaiting braids that were made into hats; the stem of the flower was used to make darts for a child's game.

kō A native tree, Cordia subcordata, with a wood prized for its grain and ease of carving. It was used for carving a wide variety of objects from platters to images of gods; the leaves were made into dye and the flowers were also used in lei making.

kukui The candlenut tree, Aleurites moluccana, introduced to Hawai'i by Polynesian settlers. The outer husk of the fruit or nut was used to make a black dye for tapa and tattooing; sap from the fruit was used as medicine to treat thrush, and used as a purgative; the hard shell of the nut was used in lei making; the kernel of the nut was the source of an oil that was burned for illumination and also used as a wood varnish for surfboards and canoes; the kernel was also chewed and spit on rough seas to calm the ocean and baked kernels were mixed with salt and chili pepper to make a relish ( 'inamona); the trunk was used to make canoes and floats for fishing nets; a reddish dye was made from the bark and/or root; a gum exuded from wounded bark was used to treat tapa; the flower was mixed with sweet potato to treat thrush; the leaves were used in a poultice for swelling and infection.

'ōhi'a 'ai The mountain apple, Syzygium malaccensis, a forest tree growing up to 20 ft. high. Traditionally the trunk of the tree was used for house posts and rafters, enclosures for temples, and to curve idols. The fruit was eaten raw or dried. The bark was made into an infusion to remedy sore throats and a dye was also made from the bark.

'ulu A discoidal, smooth stone as used in 'ulu maika game; 2. Breadfruit, Artocarpus altilis.
Bibliography


Lands of Kalulu and Kaunolu, Lahaina District, Lāna‘i Island, TMK: (2) 4-9-002:061

Thomas S. Dye, PhD
February 28, 2019

Management Summary

At the request of Pulama Lāna‘i, and pursuant to Hawaii Administrative Rules §13-278-4, T. S. Dye & Colleagues, Archaeologists has prepared an archaeological data recovery report for Sites 50-40-98-1980 and 50-40-98-1981, located at Kalulu and Kaunolu, Lahaina District, Lāna‘i Island. It reports on technological analyses set out in a data recovery plan, including EDXRF analysis of lithic materials collected from Site 50-40-98-1980, and charcoal identification and dating of the fire-pits at Sites 50-40-98-1980 and 50-40-98-1981. The lithic analysis indicates that the secondarily deposited adze rejects collected from the surface of the Miki Basin 200 Acre Industrial Development project were flake blanks likely derived from outcrops on Lāna‘i Island, and that rock from sources on Maui and Hawai‘i Islands is absent from the collection. The wood charcoal and dating analyses from the two fire-pits at Sites 50-40-98-1980 and 50-40-98-1981 further strengthen the conclusion based on earlier analyses, that native forests on Lāna‘i persisted into the nineteenth century, with little evidence for cultivation of canoe plants brought to the islands by Polynesian settlers. The persistence of native forest plants on Lāna‘i contrasts with the Waimanalo Plain on O‘ahu Island, where by the mid-fifteenth century canoe plants were typical sources of firewood.

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1 Introduction

At the request of Pulama Lāna'i, T. S. Dye & Colleagues, Archaeologists has prepared an archaeological data recovery report for Sites 50-40-98-1980 and 50-40-98-1981 located in the lands of Kalulu and Kaunolu, Lahaina District, Lāna'i Island (fig. 1). Sites 50-40-98-1980 and 50-40-98-1981 were identified and inventoried by DiVito et al. [10]. A data recovery plan was drawn up a few years later [12] that followed recommendations set out in the inventory survey report [10]. The data recovery plan proposed to carry out technological analyses of lithic materials collected from Site 50-40-98-1980, and charcoal identification and dating of the fire-pits at Sites 50-40-98-1980 and 50-40-98-1981. This document presents the results of these technological analyses and interprets them in the context of research questions having to do with the tempo of vegetation change on Lāna'i's following discovery and settlement by Polynesians, and characteristics of lithic technology to determine reduction sequences for certain tools and likely source locations for the fine-grained, tool-grade basalt used to fashion the tools.

2 Data Recovery Plan

The data recovery plan for the project is summarized in the following sections.


Site 50-40-98-1980 is located in the northernmost portion of the project area in a highly eroded area along the fence line boundary with the Lāna'i Airport (fig. 1). The site comprises two components, a lithic scatter and an eroded and exposed fire-pit. The lithic scatter is located on the crest of a slope and extends south along a drainage cut. The scatter covered an area of approximately 30 x 120 m (meter) and, at the time of survey, contained 30 or more pieces of flaked basalt. All of the artifacts that were observed and collected from the scatter came from within or adjacent to the existing drainage in areas that lacked vegetation. A cowry shell fragment and several pieces of branch coral were observed within the scatter. Three adze rejects, a hammerstone, a waterworn pebble mānuka, and a piece of branch coral were collected from the scatter (fig. 2). No artifacts were observed or collected in the vegetated areas around the drainage.

The second component of Site 50-40-98-1980 was an exposed fire-pit remnant located within the lithic scatter on the crest of the slope in a heavily eroded area. The fire-pit remnant was observed over an approximately 75 cm diameter area and, at the time of survey, contained 30 or more pieces of flaked basalt. All of the artifacts that were observed and collected from the scatter came from within or adjacent to the existing drainage in areas that lacked vegetation. A cowry shell fragment and several pieces of branch coral were observed within the scatter. Three adze rejects, a hammerstone, a waterworn pebble mānuka, and a piece of branch coral were collected from the scatter (fig. 2). No artifacts were observed or collected in the vegetated areas around the drainage.

This suggests that the artifacts have either moved downslope from a higher location as a result of water erosion or that the site has eroded and deflated over time. In either case, the artifacts would have been secondarily deposited from their original position.

The second component of Site 50-40-98-1980 was an exposed fire-pit remnant located within the lithic scatter on the crest of the slope in a heavily eroded area. The fire-pit remnant was observed over an approximately 75 cm diameter area and had exposed charcoal and a few small cobble-size fire-affected rocks on the surface and eroding downslope (fig. 3). No black plastic or tubing was observed in or around the fire-pit because the plow zone in this location had completely eroded away. It is likely that the fire-pit had originally been truncated by plows when the pineapple field was cultivated. Following documentation of the fire-pit remnant, the fire-pit was bisected twice to determine its size and stratigraphic position (fig. 4).

The first bisection point, A to A', cut the fire-pit in half to expose the stratigraphic section. Following bisection, a 15 cm deep profile was exposed. Context 16, a loose red silty clay loam sediment, was present from the current ground surface to a depth of 3 cm. It appears that the sediment has been deposited over the fire-pit due to water erosion along the drainage. The fire-pit, Context 15, is a band of charcoal that extends from 3 cm below surface to a depth of 12 cm. The fire-pit at this location is approximately 60 cm wide and is basin shaped. The interface between the Context 15 fire-pit and the material it had been dug into, the Context 2 dark reddish brown silty clay loam hard pan soil, was recorded as Context 17. The Context 2 soil was present to the base of excavation at 15 cm below surface.

The second bisection point, B to B', was cut just in front of the two rocks that were exposed on the surface. Following bisection, a 20 cm deep profile was exposed. Context 16, a loose red silty clay loam sediment, was present from the current ground surface to a depth of 6 cm. The sediment has been deposited over the fire-pit due to water erosion along the drainage. The fire-pit, Context 15, is a curved band of charcoal that extends from 6 cm below surface to a maximum depth of 15 cm. The fire-pit at this location is...
approximately 75 cm wide and is basin shaped. The interface between the Context 15 fire-pit and the material it had been dug into, the Context 2 dark reddish brown silty clay loam hard pan soil, was recorded as Context 17. The Context 2 soil was present to the base of excavation at 20 cm below surface. A charcoal sample was collected from each profile after bisection for wood taxa identification and 14C analysis.

A subsurface cultural deposit recorded as Site 50-40-98-1981 was identified in a backhoe trench (see fig. 1, p. 4). The deposit was a truncated fire-pit remnant exposed in the southern profile of the backhoe trench (fig. 6). The fire-pit was truncated by the plow zone layer, Context 1, present to a depth of 35 cm below surface. The upper portion of the fire-pit appears to have been destroyed by a plow moving east to west; charcoal from the fire-pit is scattered an additional 65 cm to the west within the plow zone. The fire-pit remnant is approximately 65 cm in width, approximately 10 cm thick, basin shaped, and is present between 35 and 45 cm below surface. A single rounded volcanic cobble was observed within the feature. The fire-pit had been excavated into Context 2, a dark reddish brown silty clay hardpan soil present to a depth of 100 cm below surface.

The interface between the fire-pit and the Context 2 soil it had been excavated into was recorded as Context 13. Context 2 overlay Context 9, a dark brown silty clay loam present to the base of excavation at 150 cm below surface. A charcoal sample was collected from the Context 12 fire-pit for wood taxa and 14C analysis.

Sites 50-40-98-1980 and 50-40-98-1981 were evaluated as significant for the important information on Hawaiian history and prehistory that they have yielded [10:96].

2.2 Research Objectives

The inventory survey report recommended that a data recovery plan be developed and implemented prior to construction activities at the Miki Basin 200 Acre Industrial Development. It was further recommended that the data recovery plan develop research questions that can be addressed with data yielded by the following laboratory tasks:

Site 50-40-98-1980 Analysis of the wood charcoal collected from the Context 15 fire-pit for taxa identification and 14C dating. Analysis of artifacts collected from the Context 18 lithic scatter to further investigate the tool-making reduction sequence utilized on the island [28].
The research objectives of the proposed data recovery investigations include gathering data on the history of vegetation change on Lāna'i in an effort to date two periods of change, one during the traditional Hawaiian period and the other in the mid-nineteenth century when sheep and goats were raised on the island [19], and to complete paired technological and geochemical sourcing analyses of the lithic artifacts to determine the reduction sequences for the flaked stone implements, and to determine likely source locations for the fine-grained, tool-grade basalt items in the collection.

The first period of vegetation change that will be investigated involves a process identified as landscape transport [3; 20], whereby the Polynesian settlers of Hawai'i established about 28 species of plants brought to the islands from a homeland in the southern hemisphere [29;321 ff.]. This process has been dated to the mid-fifteenth century on O'ahu Island [16], but thus far has proved elusive on Lāna'i, where native plants dominate firewood throughout the traditional Hawaiian sequence. For example, wood charcoal from five taxa introduced by Polynesians, including cf. kou, ipe, kikui, 'aliu, and 'ohi'a 'i'i was recovered in small amounts (generally less than 1% by weight) in all of the charcoal collections from two sites at the coastal settlement in Kaunolu [2]. Based on the available dating evidence, the charcoal collections at Kaunolu date to late in the
is it sequence along the lines set out by Weisler [28], and classify tools according to function [26], as far as possible given the fragmentary materials.

2.3 Data Needs, Methods, and Curation

The data needed to address the research objectives were collected during the inventory survey and comprise the contents of the two fire-pits and the secondarily deposited stone artifacts collected at Site 50-40-98–1980.

Field methods are not required to acquire and analyze the data because exhaustive field collections were made during the archaeological inventory survey, when both fire-pits were fully excavated and diagnostic materials were collected from the secondary deposit of stone artifacts at Site 50-40-98–1980.

The laboratory work needed to carry out the data recovery investigation includes: i) identification of charcoal from the fire-pits at Sites 50-40-98–1980 and 50-40-98–1981 at the Wood Identification Laboratory of International Archaeological Research Institute (WIDL); ii) accelerator mass spectrometry (AMS) dating of a single specimen of identified, short-lived, wood charcoal from each of the fire-pits; iii) calibration of the AMS dating results with the BCal software package [6] to estimate calendar dates for construction and use of the fire-pits; iv) non-destructive geochemical characterization of the lithic materials collected from Site 50-40-98–1980 with the EDXRF facility at the University of Hawai‘i at Hilo [22]; and v) observation of the adze rejects collected from Site 50-40-98–1980 to determine the primary reduction technique used in their manufacture.

The procedure for depositing collections after the conclusion of the data recovery project returned them to the Lāna‘i Culture and Heritage Center, where they were previously stored.

The plan does not call for additional fieldwork. Thus, we do not anticipate that human burials will be disturbed.

Sites 50-40–98–1980 and 50-40–98–1981 were determined significant under criterion "d" for the important information on Hawaiian history and prehistory they have yielded [10:96]. Sites 50-40–98–1980 and 50-40–98–1981 were not determined significant for criterion "e," which pertains to sites that have "an important value to the native Hawaiian people or to another ethnic group of the state due to associations with cultural practices once carried out, or still carried out, at the property or due to associations with traditional beliefs, events or oral accounts—these associations being important to the group’s history and cultural identity" (§13-275-6(b)(5)). Thus, there is no requirement that consultation with members of a relevant ethnic group be undertaken during preparation of this plan.

3 Laboratory Results

This section presents the laboratory results for the wood charcoal identification and dating, the EDXRF geochemical sourcing analysis, and observations on the reduction sequence for six adze rejects.
3.1 Wood Charcoal Identification and Dating


The freshly fractured transverse, tangential, and radial facets of selected charcoal fragments were examined with an epi-illuminated microscope at magnifications of 50–500x. Taxonomic identifications were made by comparing observed anatomical characteristics with those of woods in the IARI reference collection. Vouchers associated with this collection have been verified and archived at the Department of Botany, University of Hawai‘i at Mānoa. Other published references, including books, journal articles, technical documents, and wood atlases, were also consulted.

Samples were first reviewed under low-power magnification to assess the quality of the material and determine the range of plant parts present. For the most part, the charcoal in these samples is firm and somewhat hard. A selection of 40 fragments of various sizes and shapes were selected from each sample for taxonomic identification. These samples were not taxonomically diverse and consist mainly of various shapes and size classes of 'ilima and 'akoko (tables 1 and 2). All are genera that include native Hawaiian hardwood species.

Table 1: Taxa identified from charcoal

<table>
<thead>
<tr>
<th>Family</th>
<th>Taxon Name</th>
<th>Habit</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chenopodiaceae</td>
<td>Chenopodium amarum</td>
<td>shrub</td>
<td>native</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>Euphorbia sp.</td>
<td>shrub-tree</td>
<td>native</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Senna sp.</td>
<td>tree</td>
<td>?</td>
</tr>
<tr>
<td>Malvaceae</td>
<td>Sida cf. fallax</td>
<td>shrub</td>
<td>native</td>
</tr>
</tbody>
</table>

Table 2: Charcoal identifications

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Part</th>
<th>Count</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 50–40–98–1980, Context 12</td>
<td>Chenopodium amarum</td>
<td>twig</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Sida cf. fallax</td>
<td>twig</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Euphorbia sp.</td>
<td>twig</td>
<td>1</td>
</tr>
<tr>
<td>Site 50–40–98–1980, Context 15</td>
<td>Euphorbia sp.</td>
<td>twig</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Senna sp.</td>
<td>wood</td>
<td>3</td>
</tr>
</tbody>
</table>

It should be noted that while the native plant S. fallax is fairly common in archaeological assemblages there are several post-Contact Sida, including S. rhombifolia or Cuba jute, which was introduced in the 1830's (23:Table 2), and other species that are naturalized throughout the islands. In a brief review of several new wood specimens, I noted the wood anatomy of these taxa might not be diagnostic to species pending further investigation. Senna and Euphorbia also have naturalized species that are present today on Lana‘i and should be considered similarly.

Please note the following:

- Indeterminate material was too fragile or warped for taxonomic identification, or derives from small woody herb or fern stems which are rarely diagnostic. I have noted whether material was wood, herbaceous stems, grass stems, etc., whenever possible.
- It is best to choose one fragment of material for radiocarbon dating to eliminate the chance of dating more than one event [4].

Descriptions of the wood anatomy observed in the samples follow.

**Euphorbia sp.** Smaller diameter vessels, most under 50 μm, round, often chained radially 2-4 (sometimes up to 8-10); fibers medium thickness, fine pits noted on fiber walls; rays uniseriate and sometimes up to 3-4 seriate with occasional radial canals, cells square or upright; intervessel pits oval, alternate, medium-sized.

**Sida cf. fallax** Vessels small, under 40 μm diameter, solitary or by 2-3(4); surrounded by thin sleeve of axial parenchyma; fiber walls very thick; rays narrow, bi-seriate, extremely tall in TLS; intervessel pits alternate, 3-4 μm.

**Senna sp.** Vessels approximately 100 μm diameter, solitary or in groups or chains of 2-3, fibers medium-thick; axial parenchyma wavy, surrounds vessels and intergrades with fibers; rays uniseriate occasionally widening to 2 cells, a few rays are 2-3 cells wide, short to medium heights, mostly of square and some upright cells; intervessel pits 4-5 μm and also wider; alternate; vessel-ray pits similar.

Two pieces of wood charcoal were selected for 14C dating. A piece of 'ilima charcoal from the fire-pit at Site 50–40–98–1981 and a piece of 'akoko charcoal from the fire-pit at Site 50–40–98–1980 were submitted to Beta-Analytic for AMS dating (appendix A).

Beta-Analytic assigned the 'ilima charcoal to Beta-510703 and reported a conventional radiocarbon age of 140 ± 30 yr. Beta-Analytic assigned the 'akoko charcoal to Beta-510704 and reported a conventional radiocarbon age of 170 ± 30 yr. The calibrated age estimates indicate both fire-pits were used near the end of traditional Hawaiian times (fig. 8).

3.2 Reduction Sequence

Compared to island groups elsewhere in Polynesia, Hawaiian adzes are remarkably uniform. An early study that compared Hawaiian adzes with adze collections from the Society Islands, Marquesas, and Easter Island in East Polynesia remarked that "[t]he place in East Polynesian exhibits such a steadfast adherence to one form of adz as Hawai‘i."
An early study of adze making at the sources along the bench at the east end of the Pālahau Basin observed that "the corners of bowlders have been broken off to furnish the cores" [18:77]. Subsequently, a more detailed study determined that adze blanks at Kapohaku were flakes, rather than cobbles or tabular pieces of rock [28], consistent with Emory’s observation. The striking platform of the flake became the poll of the finished adze and the flake termination became the cutting edge. Adzes made from flakes: i) are typically thin relative to width and exhibit a cross section that is rectangular, rather than square [8]; ii) often increase in width toward the cutting edge; and iii) are relatively lightweight. These characteristics identify tools suited for everyday household and gardening tasks, rather than felling large trees in old growth forests.

The six adze rejects collected during the inventory survey (fig. 9) are flakes that can be classified as adze blanks because they each lack the three bi-directionally flaked edges that identify a preform [7]. They appear to have been rejected early in the reduction sequence.

Miki Basin fire-pit age estimates

Beta 510704

Beta 510703

1700
1750
1850
1900
1950
2000

Calendar year

67\% credible intervals

Figure 8: Estimated ages of the Miki Basin fire-pits. Beta-510703 has a 67\% credible interval of AD 1681–1862, with a median of AD 1809. Beta-510704 has a 67\% credible interval of AD 1668–1810, with a median of AD 1772.

(17:162). The typical Hawaiian adze was described as "quadrangular (or rectangular) in cross section and, except for some small specimens and a few of medium size, are tanged" [17:162–163]. Adzes with trapezoidal, triangular, lenticular, or plano-convex sections, all common to varying degrees in the other East Polynesian assemblages are either rare or absent from Hawai‘i. Hawaiian adzes were manufactured by flaking and grinding, without the pecking technique practiced elsewhere.

Recently, replication experiments have determined reduction sequences for quadrangular adzes from a variety of blank types, including cobbles, flakes, and tabular pieces of rock. The demonstrated feasibility of producing adzes from a wide range of blank types means that Hawaiians could have used basalt outcrops and concentrations of subrounded cobbles and boulders, and not simply specialised quarries where large flakes could be obtained. [8:82]

The wide distribution of adze rock in Hawai‘i does not mean that adzes were easy to acquire or to produce. In fact, the common Hawaiian quadrangular cross section adze requires great skill to produce.

Hawaiian quadrangular adzes require precise bidirectional flaking of four right-angled edges, while also creating flat faces on all sides. This is very difficult to achieve on tough basalt using basalt hammer stones. The extremely large and refined examples of prehistoric Hawaiian adzes indicate very high levels of skill and use of hammer stones of different sizes, weights and stone material. [8:71]

It has been estimated that reasonable skill in producing quadrangular section adzes in Hawai‘i might have taken "several years of instruction and practice to achieve ... [which] may explain the huge numbers of broken and rejected preforms on quarries across the Hawaiian archipelago" [8:82].

Figure 9: Dorsal (left) and ventral (right) surfaces of secondarily deposited adze rejects included in the EDXRF analysis: a, Lana‘i source assignment; b, Kilauea source assignment; c, Waiahole source assignment; d, Lana‘i source assignment; e, Kilauea source assignment; f, Kilauea source assignment. The scale bar is 1 cm.

3.3 Lithic Sourcing

Fine-grained rock suitable for adze manufacture is widely distributed around the islands. Exposures of the highest quality adze rock that were heavily exploited have been identified as "quarries" despite their being surface exposures that could be exploited without
the deep excavation typically associated with quarrying [5; 24]. Adze-quality rock was also found outside the "quarries", perhaps most typically as cobbles and small boulders in stream beds, but also as boulder outcrops from which flakes might be removed. The large number of potential sources complicates efforts to identify the rock source of an adze or an adze reject.

Sourcing can be accomplished by a variety of means, including: i) description of thin sections and comparison with a reference collection of source thin sections [9]; ii) destructive analyses that yield high-quality geochemical data that can be compared to published analyses of geologic exposures [24]; and iii) non-destructive EDXRF analyses that yield limited geochemical data that can be compared to EDXRF analyses of source materials [22]. A two-stage characterization process is sometimes employed to maximize the utility of results and minimize the destruction of samples [21]. At the first stage, large numbers of samples are analyzed non-destructively with EDXRF to establish geochemical groups and identify outliers. At the second stage, a few samples are selected for destructive analysis, typically in the hope of identifying the local sources of groups and identifying imports among the outliers. For example, in a study of fine-grained basalt artifacts collected from habitation and ritual structures in the Kahikinui district of Maui, EDXRF analysis of 328 artifacts divided them into 17 groups. The EDXRF results were, in most cases, insufficient to assign groups to particular source locations or quarries. Nevertheless, plausible inferences based on the EDXRF results were followed up by destructive wavelength dispersive X-ray fluorescence (WDXRF) analysis of nine samples. WDXRF analysis typically yields results that can confidently assign samples to particular source locations or quarries based on published geochemical analyses. In the Kahikinui case, WDXRF was designed primarily to form up the identification of one of the EDXRF groups, Group I, as having originated at the well-known Mauna Kea adze quarry. The adze rock at Mauna Kea is extremely fine-grained and isotropic, two qualities that enhance its value as a raw material for adze manufacture [9]. The WDXRF analysis yielded results that confirmed a Mauna Kea origin for six Group I samples, and this made it possible to assign the other four samples in Group I a Mauna Kea origin based on the EDXRF results [21].

The WDXRF analysis also matched EDXRF group D with a source at Kaunolu. Twenty-five of the Kahikinui artifacts were assigned to Group D, which would make Kaunolu the leading supplier of imported adze rock to the Kahikinui sites. About 8% of the adze rock analyzed from the Kahikinui sites originated on Lana'i.

Adze rocks collected on Lana'i have been analyzed with EDXRF at least twice, once for the Miki Basin 200 Acre Industrial Development project, and earlier for an unreported project that focused on artifacts held by the Lana'i Culture and History Center. The non-destructive EDXRF analysis has obvious benefits for museum specimens with potential for public display, but, as noted above, it yields data that are unlikely to assign artifacts to particular source locations or quarries. As a preliminary stage of analysis, EDXRF can suggest a range of possible source locations or quarries, and it can usefully exclude some potential source locations or quarries. The information provided by EDXRF might point to certain artifacts as potential imports, with geochemical compositions unlikely to be found near the collection location, whose source location might be identified with additional analysis. At the same time, the EDXRF analysis might also identify artifacts that cannot be sourced to a particular location, but whose geochemical composition is similar to what might be expected from sources near the collection location.

In these circumstances, a statistical framework that can be used to distinguish possible imports from likely local artifacts based on EDXRF information might prove useful. One way to do this is with a statistical technique known as discriminant analysis. Briefly, discriminant analysis uses so-called training data to establish a set of targets and then assigns instances from a set of test data to one or another of the targets. In the present case, the training data are EDXRF analyses of adze-quality rock from potential source locations, and the test data are the EDXRF analyses of the Lana'i artifacts. In the ideal case, where all of the potential rock sources are included in the training data, and the geochemical analysis is able to distinguish among them confidently, then the discriminant analysis will correctly assign each instance of test data to its source location. In real-world situations that all short of this ideal, the discriminant analysis assignments are best interpreted more loosely, as indications of a local or non-local source and as guides for future inquiry.

The discriminant model for EDXRF analysis of Lana'i artifacts falls short of the ideal situation. Caution in the interpretation of results is clearly warranted. EDXRF training data from potential sources lacks information from many known quarry locations. The quarry data for the training set are found on the Geoarchaeology Laboratory, UH Hilo web site and include Kilauea and Mauna Kea on Hawai'i Island, Nu'u and Haleakalā on Maui Island, and Waiahole on O'ahu Island. In addition, training data were collected in 2011 by Mills and Lundblad from several locations on Lana'i (fig. 10). These Lana'i training data are lumped together in the analysis as a single Lana'i source. EDXRF analysis provides abundance estimates for several elements with varying degrees of precision and accuracy. Consequently, analyses of EDXRF results typically focus on a subset of elements chosen either because they are specifically applicable to the question at hand or because the EDXRF method yields relatively precise and/or accurate estimates for them. The present analysis focused on the elements Nickel (Ni), Copper (Cu), Rubidium (Rb), Strontium (Sr), Yttrium (Y), Zirconium (Zr), and Niobium (Nb). These are the elements chosen by the Hilo Geoarchaeology team for a principal components analysis of many of these same training data [21]. Using these seven elements, the discriminant analysis carried out here distinguishes Haleakalā, Nu'u, and Mauna Kea from the other potential sources (fig. 11). Nevertheless, the discriminant analysis based on the EDXRF estimates of the seven elemental abundances does not confidently distinguish the Lana'i sources from the Kilauea and Waiahole sources.

The success of the classification yielded by the discriminant analysis of the training data can be assessed in several ways [5:108-110]. Two common assessments are the hold-out method, which holds out a random subset of the training data and then determines whether instances are correctly assigned to source targets established with the remaining training data, and the leave-out-one cross-validation method, which assesses whether each instance of the training data is correctly assigned to a source target established by the remainder of the training data. In practice, the two methods should provide similar results with a reasonably-sized training data set. The leave-out-one cross-validation...
Six secondarily deposited adze rejects collected from the surface during the inventory survey (see fig. 9, p. 14) were analyzed with EDXRF in an effort to determine their source locations (appendix B). Using the training data described earlier the discriminant analysis assigns two adze rejects to a Lana'i source, three adze rejects to a Kilauea source, and one adze reject to Waiahole source. As discussed, the discriminant analysis does not distinguish these sources confidently; the results should not be interpreted as indicating imports from Kilauea and Waiahole. Rather, these results indicate that there is no strong evidence that any of the adze rejects was made with imported rock. At the same time, the results do offer strong evidence that the adze rejects did not originate at Haleakala or Nu'u on Maui, or Mauna Kea on Hawai'i Island.

4 Discussion

This section compares the ages and firewood composition of the fire-pits at Sites 50-40-98-1980 and 50-40-98-1981 with the ages and firewood composition of eight other fire-pits on Lana'i Island. The ages and composition of the Lana'i Island fire-pits are then compared with 33 fire-pits from coastal Waimānalo, O'ahu to distinguish temporal of vegetation change following Polynesian colonization of the islands.

Ten fire-pits on Lana'i have been investigated with a combination of wood charcoal identification and controlled radiocarbon dating using single pieces of a short-lived taxon. The combination of wood charcoal identification and controlled radiocarbon dating yields both a roster of the woods used to fuel a fire and a precise estimate of when the firing took place. Assuming that fires were fueled with wood that was available in
The calibrated ages of the individual fire-pits have already been reported [11, 13-15]. The reported dates can be used to investigate the tempo of fire-pit construction and use on Lāna'i by turning away from the estimated ages of individual fire-pits and asking instead when the first occurrence of fire-pit construction and use, when was the second occurrence of fire-pit construction and use, etc. Posing the question in this way builds upon the event view of time used in the radiocarbon dating analysis to employ instead a substance view of time typically used to frame archaeological questions. The substance view of time focuses analysis on change, which is expressed on an absolute time scale. On present evidence, the occurrence of fire-pit construction and use on Lāna'i began in the late fifteenth century and continued into the historic period (fig. 13).

The ten fire-pits investigated in this way on Lāna'i are located on the windward and south coasts and in the central basin and plateau (fig. 12). On the windward coast, the fire-pits include one exposed on the surface at Kahalepalaao and two other buried fire-pits identified in a backhoe excavation [11]. The two fire-pits investigated on the south coast were found during excavation of a beach sand deposit that was buried under alluvium deposited during and after ranching had destabilized the island's soils [15]. The fire-pit on the central plateau at Site 50-40-98-01984 was exposed on an eroding surface located on the outskirts of an abandoned pineapple field. In addition to the fire-pits in the central basin investigated in this report, the two fire-pits at Sites 50-40-98-01986 and -01987 were discovered beneath the plow zone of an abandoned pineapple field [13].

The vicinity of the fire-pit, combined identification and dating analyses potentially yield a record of regional vegetation change over time. The plausibility of the assumption and the ability of the combined identification and dating analyses to yield a record of regional vegetation change over time were established at Waimānalo, O'ahu, where replacement of the native lowland forest with canoe plants brought to the islands by Polynesian settlers was underway by the mid-fifteenth century [16].

Identification of firewood used in the Lāna'i fire-pits indicates the prevalence into the historic period of native forest, with relatively little replacement of native species by canoe plants. This finding contrasts strongly with the documented transformation of the lowland forest at Waimānalo, where canoe plants were well established by the middle of the fifteenth century (fig. 14). At a time when most Lāna'i fire-pits were fueled exclusively with native woods, Waimānalo fire-pits regularly yield firewood assemblages dominated by canoe plants. The transformation of the lowland forest evidenced at Waimānalo started late on Lāna'i and had made relatively little progress before the island's vegetation history was radically altered during the ranching era [19].

5 Conclusion

Wood charcoal identification and dating lend support to the claim made by Hawaiian tradition that Lāna'i was settled relatively late. Current evidence from the island suggests that the first fire-pits were constructed 400-500 years after Polynesians discovered the islands. However, it is extremely unlikely that the earliest evidence for human activity on
The canoe plants brought to the islands by Polynesian settlers had begun to replace native species in lowland forests by the middle of the fifteenth century at places like Waimānalo on O'ahu. This replacement of native forest by canoe plants favored by Polynesians is referred to by geographers as a process of landscape transport in which immigrants work to create settlements that resemble those of the homeland. The process of landscape transport appears to have had relatively little effect on Lāna'i prior to the ranching era; fire-pits that date late in the traditional Hawaiian period and early in the historic period were fueled almost exclusively by wood from native plants that were well adapted to the island's dry conditions and were likely established in the island's primeval forests. Canoe plants are only rarely identified in fire-pits from the island—breadfruit from Kahalepaoa, ki from Manele, and ikai, 'ohi'a 'ai, 'ithi, and ipu from Kaunolu are exceptions that prove the rule of native firewood on the island. In this respect, one conclusion of an early inquiry into Lāna'i firewood at Kaunolu—"that many dryland forest taxa apparently persisted in this region until sometime after the abandonment of the Kaunolu settlement in the mid-1800's" [1]—appears to apply more widely and likely characterizes the vegetation history of the island as a whole.

Archaeological study of the island's stone tools is at an early stage. A reduction sequence in which an initial step removed a large flake from a boulder of suitable adze rock seems to have been most common. This reduction sequence based on flakes was practiced widely in Hawai'i and was particularly common during production of small adzes. The Lāna'i adze rejects sourced for the Mīkū Basin 200 Acre Industrial Development project were likely fashioned from local rocks, but there can be little doubt that imported adzes will be identified on the island with subsequent research. Adze rock collected from traditional Hawaiian sites in Kahikinui on Maui Island is reliably sourced to Kaunolu, so adze rock was definitely moving across the narrow channel between the islands. Additional research on Lāna'i stands a good chance of turning up evidence for the import of adze rock from islands nearby.

The discriminant analysis framework outlined in this report indicates that the non-destructive EDXRF analysis carried out by the Hilo Geoarchaeology Laboratory is sufficiently powerful to distinguish at least two Maui Island sources and the fine-grained adze rock from Mauna Kea from Lāna'i adze rocks. Other potential imports, from Waiahole Valley. The combination of a perennial stream that could feed ʻalo'i kalo, sand beaches, shallow water fishing grounds, and relatively easy access to Maui and Mōloka'i Islands all point to the desirability of the island's windward coast for traditional settlement. The windward Lāna'i coastline that Hawaiians knew is today deeply buried by sediment that eroded off the mountain during and after the ranching period, when large herds of grazing herbivores wreaked havoc on the native vegetation and destabilized soils over much of the island [19]. The widespread, severe erosion of upland soils that resulted likely biased the effect of sealing early cultural deposits along the windward coast under a thick blanket of sediment that serves to protect them from erosion and disturbance. In the event the windward coast of Lāna'i is developed, one focus of historic preservation efforts should identify and recover evidence of this early settlement.

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### Bibliography


### A 14C Dates

| Beta-510703 | 140 ± 30 14C = -22.0% | Sample consists of one piece of *Sida cf. fallax* twig charcoal from Site 50-40-98-01981, Context 12. Submitted 2018–11–26. Context 12 is described as fire-pit in backoe trench. It is classified as a cultural event. Comment: *Sida cf. fallax* twig is a short-lived material. The dated material has a highly probable association with the target event, which is fire-pit use. This short-lived material is confidently associated with use of the fire-pit feature. It provides the best estimate of when the fire-pit feature was last used. The submitted sample yielded ample carbon for dating and was processed normally in the laboratory. |

| Beta-510704 | 170 ± 30 14C = -10.4% | Sample consists of one piece of *Euphorbia cf. celastroides* twig charcoal from Site 50-40-98-01981, Context 15. Submitted 2018–11–26. Context 15 is described as the base of a truncated fire-pit exposed in an erosion swale. It is classified as a cultural event. Comment: *Euphorbia cf. celastroides* twig is a short-lived material. The dated material has a highly probable association with the target event, which is fire-pit use. This short-lived material is confidently associated with use of the fire-pit feature. It provides the best estimate of when the fire-pit feature was last used. The submitted sample yielded ample carbon for dating and was processed normally in the laboratory. |

### B EDXRF Data

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*Note: All data in parts per million.*

23


Miki Basin Industrial Park
Environmental Assessment

Exhibit B

Flora and Fauna Study
FLORA AND FAUNA STUDY
MIKI BASIN 200 ACRE INDUSTRIAL DEVELOPMENT
KALULU AND KAUNOLŪ, LĀNAʻI

by:
Robert Hobdy
Environmental Consultant
Kokomo, Maui
April 2018

Prepared for:
Pūlama Lānaʻi

INTRODUCTION

The Miki Basin 200 acre Industrial Development project is located on the inner slopes of Miki Basin and a small portion of Pālawai Basin in southwestern Lānaʻi to the east of Lānaʻi Airport. Miki Road runs through the project area and the project area also surrounds the Maui Electric Company Power Plant within the Basin. All of the lands within and around the project area are owned and managed by Pūlama Lānaʻi.

SITE DESCRIPTION

The project area is situated on gently to moderately sloping lands that were part of a large pineapple plantation. These lands have lain fallow for 25 years since the plantation closed in 1992 and are now overgrown with a dense grassland and shrubs. Soils consist of three series characterized as Waikapū silty clay loam, 0 – 3% slopes, Molokaʻi silty clay loam, 3 – 7% slopes and Uala silty clay loam, 7 – 15% slopes which are all variants of deep, well-drained soils of the upland plateau of Lānaʻi, (Foote et al, 1972). Rainfall averages about 20 inches per year with winter maximums (Armstrong, 1983). Elevations range between 1,150 feet and 1,310 feet above sea level.

SURVEY OBJECTIVES

This report summarizes the findings of a flora and fauna study of the proposed Miki Basin 200 Acre Industrial Development Project that was conducted in April 2018. The objectives of the survey were to:

1. Document what plant and animal species occur on the property or may likely occur in the existing habitat.
2. Document the status and abundance of each species.
3. Determine the presence or likely occurrence of any native flora and fauna, particularly any that are federally listed as Threatened or Endangered. If such occur, identify what features of the habitat may be essential for these species.
4. Determine if the project area contains any special habitats which if lost or altered might result in a significant negative impact on the native flora and fauna in this part of the island.
BOTANICAL SURVEY REPORT

SURVEY METHODS

A walk-through botanical survey method was used to cover this 200 acre project area. All parts of this habitat were examined.

A complete inventory of all plant species was made with special attention focused on native plant species and whether any of these were federally protected Threatened or Endangered species that might require special attention or actions.

DESCRIPTION OF THE VEGETATION

The entire project area has lain fallow from agricultural use for 25 years, with some grazing occurring during a few of these years. The vegetation was a dense growth of grasses and shrubs. Thirty-nine plant species were recorded during the survey.

Two species were abundant throughout the project area, Guinea grass (*Megathyrsus maximus*) and lantana (*Lantana camara*). Another two species were common, sourgrass (*Digitaria insularis*) and Madagascar fireweed (*Senecio madagascariensis*). The remaining thirty-five species were either of uncommon or rare occurrence.

Just three common native plant species were found, ʻilima (*Sida fallax*), ʻuhaloa (*Waltheria indica*) and ʻaʻaliʻi (*Dodonaea viscosa*), all of which are widespread and common throughout Hawaii. These have persisted here in small numbers due to their hardy nature.

DISCUSSION AND RECOMMENDATIONS

The vegetation in this project area is dominated by hardy, invasive non-native species. Just three common native plant species, ʻilima, ʻuhaloa and ʻaʻaliʻi, were found here. None of these are of any conservation concern. No special habitats for native plants were found. Because of the above information, it is determined that there is nothing of special botanical concern with regard to this project. No recommendations with reference to plants are deemed necessary.

PLANT SPECIES LIST

Following is a checklist of all those vascular plant species inventoried during the field studies. Plant families are arranged alphabetically. Taxonomy and nomenclature of the flowering plants (Monocots and Dicots) are in accordance with Wagner et al. (1999).

For each species, the following information is provided:
1. Scientific name with author citation.
2. Common English or Hawaiian name.
3. Bio-geographical status. The following symbols are used:
   - endemic = native only to the Hawaiian Islands; not naturally occurring anywhere else in the world.
   - indigenous = native to the Hawaiian Islands and also to one or more other geographic area(s).
   - non-native = all those plants brought to the islands intentionally or accidentally after western contact.
   - Polynesian = brought by the Hawaiians during Polynesian migrations.
4. Abundance of each species within the project area:
   - abundant = forming a major part of the vegetation within the project area.
   - common = widely scattered throughout the area or locally abundant within a portion of it.
   - uncommon = scattered sparsely throughout the area or occurring in a few small patches.
   - rare = only a few isolated individuals within the project area.
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<thead>
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<td>Madagascar fireweed</td>
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<td>CONVOLVULACEAE (Morning Glory Family)</td>
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<td>Indigofera suffruticosa Mill.</td>
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</tr>
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<td>non-native</td>
<td>rare</td>
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<tr>
<td>Sida ciliaris L.</td>
<td>bracted fanpetals</td>
<td>non-native</td>
<td>rare</td>
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<td>Sida cordifolia L.</td>
<td>flannel sida</td>
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<td>rare</td>
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<tr>
<td>Sida fallax Falder</td>
<td>'ilima</td>
<td>indigenous</td>
<td>uncommon</td>
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<tr>
<td>Sida rhombifolia L.</td>
<td>arrowleaf sida</td>
<td>non-native</td>
<td>rare</td>
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<td>sand mallow</td>
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<td>uncommon</td>
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<td>uncommon</td>
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<td>Verbena littoralis Kunth</td>
<td>ha'ū 'ūwī</td>
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<td>rare</td>
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<td>**MALVACEAE (Mallow Family)</td>
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<td>Malvastrum coronelanderianum (L.) Garcke</td>
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<td>Oxalis corniculata L.</td>
<td>'ihi 'ai</td>
<td>Polynesian</td>
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</table>
FAUNA SURVEY REPORT

SURVEY METHODS

A fauna survey was conducted in conjunction with the flora survey. All parts of the project area were covered. Observations were made with the assistance of binoculars. Notes were made of species, numbers and status as well as on tracks, scat and signs of feeding. An inventory was made of all of the animal species encountered.

In addition, an evening survey was conducted to observe crepuscular activities and calls, and to determine any occurrence of the Endangered Hawaiian hoary bat (*Lasirius cinereus semotus*) in the project area.

RESULTS

**MAMMALS**

Just one mammal species was observed in the project area. A herd of about 20 axis deer were seen and trails, tracks and feeding damage were everywhere. Nomenclature and taxonomy follow (Tomich, 1986).

A special effort was made to look for evidence indicating the presence of ōpe′ape′a or Hawaiian hoary bat by conducting an evening survey at two locations within the project area. A bat detecting device (Batbox III D) was employed, set to frequency of 27,000 Hertz that these bats are known to use when echolocating for flying insects. No bats were detected with the use of this device.

Other non-native mammals likely to frequent this area include rats (*Rattus* spp.), mice (*Mus domesticus*), feral cats (*Felis catus*), and occasionally domestic dogs (*Canis familiaris*).

**BIRDS**

Birdlife was of moderate occurrence in the project area. Twelve species were observed during three site visits, but none were particularly common. Taxonomy and nomenclature follow the American Ornithologists’ Union (2018). Eight bird species were of modest occurrence, cattle egret (*Bubulcus ibis*), zebra dove (*Geopelia striata*), nutmeg mannikin (*Lonchura punctulata*), gray francolin (*Francolinus pondicerianus*), northern mockingbird (*mimus polyglottos*), common myna (*Acridotheres tristis*), Eurasian sky lark (*Alauda arvensis*) and Pacific golden-plover (*Pluvialis fulva*). The other four species were of rare occurrence.

Two native bird species were recorded, the indigenous and migratory kōlea or Pacific golden-plover and the endemic pueo or Hawaiian owl (*Asio flammeus sandwichensis*).

A few other non-native bird species may occasionally occur in this area, but this habitat is unsuitable for Hawaii’s native forest birds or seabirds.

**INSECTS**

Insect life was rather sparse in this habitat during three site visits. Twelve non-native species were recorded, representing five insect Orders. Just one species was common throughout the project area, the monarch butterfly (*Danaus plexippus*). Two other species were uncommon, the cabbage butterfly (*Pieris rapae*) and the short-horned grasshopper (*Oedaleus abruptus*). Taxonomy and nomenclature follow Nishida et al (1992).

No native insect species were seen.

**DISCUSSION AND RECOMMENDATIONS**

The fauna recorded in this project area is largely non-native in character. Axis deer are abundant throughout the area and have significantly modified the habitat by reducing plant species to a few hardy dominants. This in turn has a somewhat limiting effect on resource availability for other mammals, birds and insects.

No Endangered Hawaiian bats were detected in the project area during the survey. They are rare on Lāna‘i but could occur in this area occasionally. The U.S. Fish and Wildlife Service has guidelines that ensure that these bats are not harmed should they show up.

Just two bird species were native to Hawaii, the kōlea and the pueo. The kōlea breed and raise their young in the arctic and then migrate to tropical places like Hawai‘i to overwinter. Many thousands of kōlea come to Hawaii every winter. Kōlea are quite common and have no endangered or threatened status.

The pueo is a race of the short-eared owl species that is endemic to Hawaii. It occurs on all the islands but is rare on O‘ahu. It is wide ranging in grasslands and shrublands on Lāna‘i. It carries no federal endangered or threatened status.

Two indigenous seabirds the Endangered ‘ua‘u and the Threatened ‘a‘o, while not nesting in the project area, do fly over it during dusk to access their burrows high in the mountains and again at dawn to head out to sea. Young birds taking their first fledging flights are inexperienced fliers. They often are disoriented by bright lights and crash into light structures where they become vulnerable to injury and predators. It is recommended that any significant outdoor lighting associated with the proposed project be hooded to direct the light downward to mitigate this threat.

No other recommendations with reference to fauna are deemed necessary.
ANIMAL SPECIES LIST

Following is a checklist of the animal species inventoried during the field work. Animal species are arranged in descending abundance within three groups: Mammals, Birds and Insects. For each species the following information is provided:

1. Common name
2. Scientific name
3. Bio-geographical status. The following symbols are used:
   - endemic = native only to Hawaii; not naturally occurring anywhere else in the world.
   - indigenous = native to the Hawaiian Islands and also to one or more other geographic area(s).
   - migratory = bird species that spend the fall and winter months in Hawaii and the spring and summer months breeding in the arctic.
   - non-native = all those animals brought to Hawaii intentionally or accidentally after western contact.
4. Abundance of each species within the project area:
   - abundant = many flocks or individuals seen throughout the area at all times of day.
   - common = a few flocks or well scattered individuals throughout the area.
   - uncommon = only one flock or several individuals seen within the project area.
   - rare = only one or two seen within the project area.

<table>
<thead>
<tr>
<th>SCIENTIFIC NAME</th>
<th>COMMON NAME</th>
<th>STATUS</th>
<th>ABUNDANCE</th>
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<tr>
<td><strong>MAMMALS</strong></td>
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<td>CERVIDAE (Deer Family)</td>
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<td>axis deer</td>
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<tr>
<td><strong>BIRDS</strong></td>
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<td>STATUS</td>
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<td><strong>ORTHOPTERA</strong></td>
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<td>Oedaleus abruptus Thunberg</td>
<td>short-horned grasshopper</td>
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</table>

Figure 1. Miki Basin 200 acre Industrial Development Project Area in southwestern Lāna'i
Figure 2. View west showing the Guinea grass and lantana shrubland characteristic of western portion of the project area in Miki Basin

Figure 3. View northeast across the Pālōwai Basin portion of the project area showing a guinea grass and lantana shrubland
Literature Cited


