



BIOLOGICAL SURVEY ON A 10-ACRE PARCEL  
AND ADJACENT AREAS, PROPOSED LAND  
ACQUISITION, KAHULUI, MAUI, HAWAII

Hawaii  
Biological  
Survey

Final Report

February 2014

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PROPOSED LAND ACQUISITION, KAHULUI, MAUI, HAWAII**

**FINAL REPORT**

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## EXECUTIVE SUMMARY

In April 2013 a request was made by the U.S. Fish and Wildlife Service (USFWS) to EKNA Services, Inc., to conduct surveys for the possible presence of the endangered Blackburn's sphinx moth [*Manduca blackburni* (Butler 1880)] on properties located in the Kahului Harbor area. In December 2013 the Bishop Museum, Department of Natural Sciences, was contracted by EKNA Services, Inc., to conduct biological surveys on a 10 acre industrial-use site adjacent to the Maui Electric Company power plant located at Kahului Harbor. On 8–12 December 2013 a biological reconnaissance of the harbor area property was conducted, as well as adjacent properties to the east (State Department of Land and Natural Resources [DLNR] storage yard and the Maui County Wastewater Treatment Plant) up to the boundary with Kanahā Beach Park, and to the west (State Harbors Division) up to Pu'unēnē Avenue and the coastal beaches fronting them, comprising roughly 22 additional acres. In conjunction with the Blackburn's sphinx moth surveys, it was deemed necessary to inventory all the plant and invertebrate species found within the selected survey sites, with particular attention being paid to the alien tree tobacco (*Nicotiana glauca*), the primary host plant for the endangered moth in this area. Host plants that could serve as adult food (flower nectar) for the moth were also searched for and documented. GPS coordinates for all *Manduca* host plants found were recorded, and the presence of *Manduca* eggs, larvae, and adults, as well as evidence of chewing damage that may have been caused by *Manduca*, was searched for. Chewing damage was photographed and the locations of damaged host plants recorded. The Bishop Museum team also searched for federally listed endangered or threatened plant, animal, or insect species, a possibility especially with birds, given the close proximity to Kanahā Pond Wildlife Sanctuary, where several native endangered wetland bird species make their home. Bishop Museum also provided complete inventories of plants, invertebrates, birds, and mammals seen within the survey areas, and conducted vegetation and hydrological analyses for wetland sites noted in the survey areas.

## INTRODUCTION

Staff from the Bishop Museum, Department of Natural Sciences, on 8–12 December 2013 conducted a biological reconnaissance of 10 acres of industrial-use land adjacent to the Maui Electric Company power plant in the vicinity of Kahului Harbor (Tax Map Keys (2) 3-7-11:17, (2) 3-7-11:23), currently owned by Alexander & Baldwin, Inc., and proposed for acquisition by the State of Hawai‘i Department of Transportation, Harbors Division. The parcel is located in the Kahului Harbor area of north-central Maui in an industrial-use zone, and is bounded on the west by Hobron Lane, on the north by Amala Place, on the east by Amala Road, and to the south (*makai*) by the power plant (see Map 2, p. 39).

While there are no immediate plans to develop the site, looking ahead to potential development, the Pacific Island Office of the U.S. Fish and Wildlife Service (USFWS) in April 2013 noted that the Blackburn’s sphinx moth (*Manduca blackburni*), a federally listed endangered Hawaiian moth, was known to inhabit the general vicinity. The USFWS thus recommended that a biological survey be conducted in the project area, as well on adjacent properties, to confirm the presence or absence of adult and/or larval *Manduca*, as well as the known host plants the species needs to survive. At the request of client EKNA Services, Inc., the survey area was thus expanded to include adjacent properties to the east (State Department of Land and Natural Resources [DLNR] storage yard and the Maui County Wastewater Treatment Plant) up to the boundary with Kanahā Beach Park, and to the west (State Harbors Division) up to Pu ‘unēnē Avenue and the coastal beaches fronting them, totaling approximately 22 acres (see Map 1, p. 38). The expanded survey perimeter also included water features that were investigated in a preliminary wetland analysis.

Elevation at the site ranged from sea level to 20 feet. Average annual rainfall for the area is around 18 inches. The soil substrates in the survey area fall into three classifications in Foote et al. (1972): 1) Beaches (BS), light-colored sands derived from coral and seashells; 2) Fill Land (Fd), usually consisting of low-lying wetlands along coastal flats, coral sand, coral limestone, or areas shallow to bedrock, filled with bagasse and slurry from sugar mills; and 3) Jaucas sand, saline, 0 to 12 percent slopes (JcC), consisting of calcareous soils occurring as narrow strips on coastal plains, developed in wind- and water-deposited sand derived from coral and seashells. The Jaucas sands are saline, with a water table near the soil surface, and are poorly drained in depressions but excessively drained on knolls. Typical vegetation on JcC soils includes kiawe (*Prosopis pallida*), koa haole

(*Leucaena leucocephala*), fingergrass (*Chloris* spp.), Bermuda grass (*Cynodon dactylon*), and Australian saltbush (*Atriplex* spp.). Typical land use on JcC soils is pastureland, wildlife habitat, or urban development.

The primary objectives of the survey were to 1) record GPS coordinates of all plant hosts reported to be associated with the adult or larval stages of the endangered Hawaiian moth, *Manduca blackburni*, and briefly describe the habitat types in the survey area; 2) record physical presence of *Manduca* adults or larvae, or any physical evidence of their presence (e.g., leaf chew, droppings), also recording photographic evidence and GPS coordinates; 3) provide an inventory of plants, arthropods, birds, and mammals seen; 4) report on locations and numbers of any federally listed endangered or threatened plant, animal, or insect species; and 5) provide vegetation and hydrological analyses for any wetland areas noted (excluding soil analysis).

## SURVEY METHODS

Prior to initiation of fieldwork, the authors searched for pertinent literature on previous biological surveys conducted in the general vicinity to familiarize themselves with historical findings in the area (Howarth et al. 2012; Funk 1999; Char 1990, 1997). Literature relating to the endangered Hawaiian moth, *Manduca blackburni*, was also reviewed, especially with regard to its distribution and biology, and the U.S. Fish and Wildlife Service (USFWS) designation of critical habitats and a management unit in the general vicinity of the project site (U.S. Fish and Wildlife Service 2003, 2005; Amidon et al. 2009; Rubinoff & San Jose 2010).

A walkthrough survey method was used, with two biologists systematically combing the survey area, taking field notes, and georeferencing all targeted plant or animal species. The existing roadways and perimeter fences provided reliable reference points for location within the parcel. Garmin GPS units were used for georeferencing, and coordinate location points were recorded using the WGS 84 datum. Plant and animal identifications were largely made in the field; those that could not be positively identified were photographed or collected for later identification at Bishop Museum. Five days of fieldwork were conducted on 8–12 December 2013.

The species recorded reflects the season and environmental conditions at the time of the survey. In their response to the consultant EKNA Services, Inc., the USFWS recommended that the search

for evidence of the endangered Blackburn's sphinx moth take place during the wettest portion of the year, preferably 4–8 weeks after a significant rainfall event. One such significant rainfall event took place during Hawai'i's rainy season on 10 November 2013, when the *Maui News* reported that 3.52 inches of rainfall had been recorded during a 24-hour period at Kahului Airport, shattering the previous Kahului record of 1.78 inches set in 1955. The survey was conducted 4 weeks after this event.

Botanically, the focus was on locating all occurrences of the non-native tree tobacco (*Nicotiana glauca*) in the survey area, the main host plant in the area for the endangered moth, *Manduca blackburni*. The USFWS advisory letter also noted that adult moths fed on the nectar of the native pōhuehue or beach morning glory (*Ipomoea pes-caprae* subsp. *brasiliensis*), 'ilie'e (*Plumbago zeylanica*), and maiapilo (*Capparis sandwichiana*), and that the larvae fed on the native tree, 'aiea (*Nothocestrum latifolium*) and tree tobacco. Other sources (USFWS 2003, 2005) list the native koali 'awa (*Ipomoea indica*) as another preferred adult nectar host. All of these plants were searched for during the survey.

Also included in the search were other documented or suspected host plants of *Manduca* adults and larvae, including commercial tobacco (*N. tabacum*), eggplant (*Solanum melongena*), tomato (*Lycopersicon esculentum*), and Jimson weed (*Datura stramonium*). The presence of any other members of the tomato family (Solanaceae) or morning-glory family (Convolvulaceae) were also noted as potential larval or adult *Manduca* hosts.

## SURVEY FINDINGS

### **Objective 1: *Manduca* plant host census and habitat types**

Conservatively, 80+ plants of *Nicotiana glauca*, ranging from seedlings to trees 10 feet tall, were noted during the survey (Fig. 5, p. 47). GPS points were taken for most of the sightings (see Map 1, p. 38 for distributions; Appendix IV, p. 33, for GPS points). Very few of the *Nicotiana* plants were located within Alexander & Baldwin's 10-acre parcel; a few plants were noted in a fenced parcel referred to as the "notch" parcel (SSFM International, Inc. 2012) (see Map 2, p. 39). The largest concentration of tree tobacco plants ranged from the fenceline between the DLNR and wastewater plant to the undeveloped lands on the western end of the treatment facility proper (see Map 4, p. 41).

Although widespread and apparently supporting a population of *Manduca blackburni* in this coastal habitat, the USFWS does not consider the non-native *Nicotiana glauca* to be a *primary constituent element* (defined as those physical or biological features considered essential for the conservation of the species) for *Manduca*, for the following reasons: 1) *Nicotiana* is short-lived and drought-intolerant, and can disappear from an area during prolonged droughts, while *Nothocestrum* is more stable and persistent in dry to mesic forest habitats; 2) because of its susceptibility to droughts, *Nicotiana* is considered a suboptimal food for sphinx moth larval growth, which consume more food when it has a high water content; 3) *Nicotiana* is an established weed that land managers might prefer to control if native host plants are available; and 4) because *Nicotiana* inhabits weedy environments, potentially harmful alien insect predators are more likely to occur there (USFWS 2003, 2005).

In the surveyed lands, several other members of the Solanaceae besides tree tobacco were noted, but only in small quantities: Jimson weed (*Datura stramonium*), two plants less than 18 inches tall (see Fig. 2, p. 44); groundcherry (*Physalis angulata*), one plant, 6 inches tall; and pōpolo (*Solanum americanum*), several plants, 1 foot tall. The *Datura* and *Physalis* were found on the wastewater plant property, the *Solanum* on the DLNR site.

Among adult *Manduca* host plants, the beach morning-glory (*Ipomoea pes-caprae* subsp. *brasiliensis*) was an occasional element along the coasts, growing primarily in beach sand (Fig. 6, p. 47). Three additional members of the morning-glory family (*Ipomoea obscura*, *I. triloba*, *Jacquemontia sandwicensis*) were noted and may potentially serve as nectar sources for feeding, but all have small corolla tubes relative to the larger beach morning-glory flower. These were all infrequent in the survey area. Other documented adult hosts (*Capparis sandwichiana*, *Plumbago zeylanica*, *Nothocestrum latifolium*) were not seen during the survey.

Following are short descriptions of the main vegetation habitat types noted during the survey (complete species lists can be found in Appendix I, p. 18):

**a) Coastal dunes** (Fig. 8, p. 48). The substrate in this zone is primarily unconsolidated beach sand, and it occurs in mostly undisturbed habitats adjacent to the ocean, beginning at the high tide mark. Strong onshore breezes, constant salt spray, intense sunlight, high temperatures, low rainfall, and shifting sands are the norm in this zone. The best examples along this coast are found in Kanahā Beach Park, adjacent to the east. In its most undisturbed native expression, clumps of naupaka



kahakai (*Scaevola taccada*) form thickets at the high water mark, while the beach morning-glory (*Ipomoea pes-caprae* subsp. *brasiliensis*) trails along the sand, rooting at each node, intermingling with ‘aki‘aki grass (*Sporobolus virginicus*). Other occasional native elements include the tree milo (*Thespesia populnea*), the shrub ‘āweoweo (*Chenopodium oahuense*), and the herbs ‘ākulikuli (*Sesuvium portulacastrum*), kīpūkai (*Heliotropium curassavicum*), and alena (*Boerhavia repens*). The most common weedy elements include the trees common ironwood (*Casuarina equisetifolia*) and tree heliotrope (*Tournefortia argentea*); the shrubs Indian fleabane (*Pluchea indica*) and *P. xfosbergii*; the herbs golden crown-beard (*Verbesina encelioides*), *Heliotropium procumbens* var. *depressum*, saltbush (*Atriplex suberecta*), goosefoot (*Chenopodium murale*), and silky jackbean (*Canavalia sericea*); and the grasses buffelgrass (*Cenchrus ciliaris*) and Bermuda grass (*Cynodon dactylon*). Examples of coastal dune vegetation in the survey area are best developed on the east margin of the wastewater treatment plant property and a section of the beach fronting the treatment plant. Tree tobacco was occasionally found in this zone, but toward the inland, more sheltered side.

**b) Coastal forest** (Fig. 7, p. 47; Fig. 12, p. 49). This zone occurs mainly on the DLNR property, mostly growing on the banks of Mau‘oni Pond, readily visible on the Google Earth © maps as thickly vegetated zones (see Map 3, p. 40). These forests are dominated by the non-native trees common ironwood and kiawe (*Prosopis pallida*), with sections of hau (*Hibiscus tiliaceus*), milo, and false kamani (*Terminalia catappa*), and scattered date palms (*Phoenix dactylifera*). Very little grows under the ironwood, as it thrives on nutrient-poor coastal sands, and the needle litter is said to leach chemicals that restricts plant growth underneath it. Tree tobacco was uncommon in this habitat. In the extreme western end of the survey properties, adjacent to Pier 2, is a tall, thick common ironwood forest adjacent to a drainage channel leading to the ocean.

**c) Ruderal vegetation** (Fig. 9, p. 48). This zone is broadly defined as all areas not in a forested habitat, a natural coastal habitat, or a wetland. It includes all roadside areas with non-woody vegetation, weedy sections of industrial properties, and purposefully cultivated plantings. The entire 10-acre Alexander & Baldwin property is included here, as well as the entire interior fenced wastewater treatment plant property. Among the most common weeds in the ruderal zone were *Heliotropium procumbens* var. *depressum*, the aggressive legume vine *Macroptilium atropurpureum*, saltbush, buffelgrass, swollen fingergrass (*Chloris barbata*), *Sida ciliaris*, and the possibly indigenous ‘uhaloa (*Waltheria indica*). Almost all of the tree tobacco plants seen during the survey grew in this habitat type, concentrated on the treatment plant property and the interface with the

adjoining DLNR land to the west.

**d) Wetlands** (Fig. 7, p. 47; Figs. 10–12, p. 49). Several waterways and wetland sites were examined during the survey, mostly on the DLNR property (see Map 3, p. 40), and one on the western end of the State Harbors Division property adjacent to Pier 2 (see Map 5, p. 42). Mau‘oni Pond on the DLNR property is the remnant of an ancient royal Hawaiian fishpond complex, along with Kanahā Pond, now partially filled in for present-day industrial usage. The present-day water features are likely fed by the adjoining Kanahā Pond complex and drain into Kahului Bay during high-water events. At the time of our visit none of the channels were filled enough to connect to the ocean. Only one wetland feature, on the DLNR property, contained what would be considered typical wetland vegetation. This wetland is located in a sandy depression on the property, fronted on the Amala Place side by an unpaved vehicle lot and small dumpsite, and oceanside by sand dunes fronting Kahului Bay. Adjacent parts of the property have been bulldozed and currently are sparsely vegetated, but the vicinity of the wetland appears to have been little disturbed. The wetland is small and oval-shaped, measuring about 150 feet by 95 feet. The substrate was completely flooded, with about half of the acreage dominated by kaluhā (*Schoenoplectus californicus*), a bulrush with stems up to 7 feet tall. A smaller section was dominated by a smaller sedge, makai (*Bolboschoenus maritimus* subsp. *paludosus*), and a raised section in the middle of the wetland was colonized primarily by the shrubs Indian fleabane (*Pluchea indica*), sourbush (*P. carolinensis*), and marsh fleabane (*P. xfosbergii*). Other wetland indicator plants present included makaloa (*Cyperus laevigatus*), ‘ae‘ae (*Bacopa monnieri*), and duckweed (*Landoltia punctata*). A steep, sandy slope on the makai and western side of the wetland was thickly covered mostly with *P. xfosbergii*.

## **Objective 2: Entomological evidence of *Manduca blackburni* presence**

Known *Manduca blackburni* plant hosts were visually inspected for the presence of the endangered Blackburn’s sphinx moth as well as for other invertebrates that were present while walking between sites. An insect sweep net and small handheld aspirator were used to capture specimens. Leaves and branches of *Nicotiana glauca* were examined for the presence of *M. blackburni* eggs and larvae. Chewing damage seen on *N. glauca* was noted and photographed. Locations for general collecting and *Manduca* host searching are listed in Appendix IV (p. 33). Non-*Manduca* species were captured incidentally while walking between sites. Specimens identified in

the field and not retained were recorded. All material collected were placed in vials containing 95% ethanol, labeled, and brought back to the Bishop Museum for identification. A list of identified species are listed in Appendix II (p. 23).

### **Objective 3: Biological census**

#### **a) Plants**

A total of 137 plant species were recorded during the survey, including 5 endemic (3 of which were solely cultivated), 14 indigenous (including “questionably indigenous”), 3 Polynesian introductions (all solely cultivated), 87 naturalized weeds, and 28 cultivated plants. A complete plant species list can be found in Appendix I (p. 18). Excluding the 34 solely cultivated species noted, the low percentage of natives among the naturally occurring vegetation (17 of 103 species, 16.5%) is attributable to the highly modified nature of the site (industrial development on coastal fill land). None of the 16 naturally occurring native (endemic + indigenous) plants is a federally protected endangered or threatened species. The more common natives, by habitat type, were:

Coastal dune: kīpūkai (*Heliotropium curassavicum*), ‘āweoweo (*Chenopodium oahuense*), pōhuehue (*Ipomoea pes-caprae* subsp. *brasiliensis*), naupaka kahakai (*Scaevola taccada*), alena (*Boerhavia repens*)

Coastal forest: hau (*Hibiscus tiliaceus*), milo (*Thespesia populnea*)

Ruderal/industrial: ‘uhaloa (*Waltheria indica*)

Wetlands: ‘ākulikuli (*Sesuvium portulacastrum*), ‘ae‘ae (*Bacopa monnieri*), makai (*Bolboschoenus maritimus* subsp. *paludosus*), makaloa (*Cyperus laevigatus*)

#### **b) Arthropods**

A total of 52 species were collected while searching on and near the alien tree tobacco (*Nicotiana glauca*). The main objective of this survey was to determine if the endangered Blackburn’s sphinx moth was present on the properties surveyed. While no eggs, larvae, or adults were observed on the tree tobacco, several plants showed signs of feeding damage on their leaves. Although *N. glauca* is a known host species for the Blackburn’s sphinx moth, we can only speculate

on what caused some of the feeding damage. Damage caused by the chrysomelid beetle *Lema trilinea* was evident on many of the tree tobacco plants growing within the Kahului wastewater treatment plant (Fig. 1, p. 43)). The larvae of this beetle resemble small slugs and will feed from the edges of the leaves and also cause shot-holes in the leaves. The chewing damage caused by this beetle is characterized by irregular, jagged edges. This beetle will also feed on *Datura* spp. (Fig. 2, p. 44). At least 2 sphinx moths other than *Manduca blackburni* are known to feed on the alien tree tobacco in Hawai'i. Although tree tobacco is not their preferred host plant, the sweet potato hornworm (*Agrius cingulata*) and the white-lined sphinx (*Hyles lineata*) will feed on tree tobacco. The white-lined sphinx is roughly half the size of the other two. The feeding damage caused by the larger moths can be much more significant, with even the largest leaves being chewed to their bare stems (Fig. 3, p. 45). Because no sphingid larvae were seen during this survey, it was not possible to determine what moth species was feeding on the tree tobacco.

### **c) Birds and feral mammals**

A total of 12 bird species and 1 mammal were observed during the 5-day walkthrough surveys in the Kahului Harbor area. No endangered or threatened species were seen in the area, although the survey sites were in close proximity to the Kanahā Pond State Wildlife Sanctuary, where three endangered waterbirds reside. The Black-crowned Night-Heron (*Nycticorax nycticorax*) was the only native bird species recorded from the survey area. A complete list of species can be found in Appendix III, p. 29.

### **Objective 4: Endangered or Threatened taxa**

None of the 16 naturally occurring native (endemic + indigenous) plants noted during the survey is a federally protected endangered or threatened species. *Hibiscus clayi* is federally listed as endangered, but occurs only as a single cultivated plant in the wastewater plant landscaping.

As explained in objective 3b above, because no eggs, larvae, or adults of *Manduca blackburni* were observed on *Nicotiana glauca*, the obvious chewing damage on tobacco plants noted cannot be conclusively attributed to *M. blackburni*. Otherwise, no endangered or threatened arthropods were seen.

Although three endangered species of waterbirds—Black-necked Stilt (*Himantopus mexicanus knudseni*), Koloa (*Anas wyvilliana*), Hawaiian Coot (*Fulica alai*)—are known to reside at the nearby 235-acre Kanahā Pond State Wildlife Sanctuary, just adjacent to the south, none of them were noted in any of the wetland habitats on the surveyed properties. At the time of our survey in December 2013, the wastewater treatment plant catchment pond was completely dried up; anecdotal evidence indicates that the endangered Black-necked Stilt can be found there when the pond is filled.

### **Objective 5: Wetland analysis**

Wetlands, as defined in the Environmental Protection Agency’s regulations (40 CFR 230.3), are “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” To qualify as a wetland, a site must meet three criteria. First, there must be a predominance of hydrophytic vegetation on the site, plants typically adapted to life in water or saturated soils. The *National Wetland Plant List* (Lichvar 2013) provides recent wetland ratings of over 7,900 native and naturalized species throughout the United States, ranging from “obligate” (OBL) plants that almost always occur only in wetlands, to “upland” (UPL) plants that almost never are found in wetlands. “Facultative wetland” (FACW) plants are usually found in wetlands, but may occur in non-wetlands, while “facultative upland” (FACU) lean the other way. In the middle are “facultative” (FAC) plants that are equally adapted to both wetlands and non-wetlands. For purposes of wetland delineation, in simplified terms, the vegetation passes the wetland test if the majority of the biomass is rated OBL, FACW, or FAC.

A second criterion is the presence of wetland hydrology. It may be self-evident during the wettest part of the year, but in drier periods can be the least precise of the criteria, as it can involve relying on reading clues in the environment, such as drainage patterns, water marks, drift lines, and sediment deposits. The final criterion is the presence of hydric soils, which involves digging pits and analyzing soil profiles, textures, and colors to determine whether they are wetland soils.

For this survey, Bishop Museum agreed to analyze the presence of hydrophytic vegetation and wetland hydrology, but deferred on analyzing the presence of hydric soils. No wetland delineations were performed. Most of the water features in the survey area seaward of the adjacent Kanahā Pond Wildlife Refuge appeared to be drainage channels to the ocean exiting from Kanahā Pond. At the

time of the survey none of drainages actually connected to the ocean, and the water quality in the shallower water bodies was murky. Only one of the saturated sites actually met the three conditions required of a wetland habitat. This site occurred on the DLNR property in a depression backed on the ocean side by a steep sand dune, as described in the wetland zone description on pages 6–7 (see Map 3, p. 40). Here all of the primary vegetation within the wetland was rated as hydrophytic:

*Schoenoplectus* (OBL), *Bolboschoenus* (OBL), *Pluchea indica*/*P. carolinensis*/*P. xfosbergii* (FAC), *Cyperus* (OBL), *Bacopa* (OBL), *Landoltia* (OBL), and seashore paspalum (*Paspalum vaginatum*) (FACW), and there was obvious standing water in the depression. In the Google Earth © photo used for the maps in this report, dated 25 April 2013, it does not appear that there is any standing water in the wetland, supporting reports that Maui had been suffering through prolonged drought conditions during this time.

The other water features on the DLNR property include a drainage channel 30 feet wide (see Fig. 10, p. 49). Soil has been mounded along both banks for its entire length, apparently relatively recently, as it is currently sparsely vegetated with young trees of kiawe, milo, date palm, Christmas berry (*Schinus terebinthifolius*), and larger trees of coconut (*Cocos nucifera*) and common ironwood at the seaward end. A sand berm blocks access to Kahului Bay, and at this end there is a thick growth of the native groundcover, ‘ākulikuli (*Sesuvium portulacastrum*), along with scattered ‘aki‘aki grass (*Sporobolus virginicus*), both FAC wetland species. Also on the DLNR property are two small water-filled depressions. Pool A (see Fig. 11, p. 49) is about 60 x 20 feet, and is shallow with a thick growth of green algae. Pool B is about 40 x 15 feet, and is shaded by 30 foot tall milo and kiawe trees, with sapling date palms on its margin. Neither pool has wetland vascular plants growing in it, and these water features are probably ephemeral elements resulting from the heavy rains that fell a month prior. The final water feature on the DLNR property is Mau‘oni Pond (see Fig. 12, p. 49). This body of water is also landlocked until it reaches the level of the cement drainage pipes on the seaward end. The banks of the pond are mostly steep and covered with coastal forest trees, mostly common ironwood. In places, there are flat pond banks that support hydrophytic species such as torpedo grass (*Panicum repens*, FAC), makai (*Bolboschoenus maritimus* subsp. *paludosus*, OBL), and ‘ae‘ae (*Bacopa monnieri*, OBL), but in general the steep banks prevent development of wetlands on this site.

A drainage channel adjacent to Pier 2 (see Fig. 13, p. 50) was examined. The source of this water is unclear. Although the mouth of this waterway is within several feet of the ocean, it, too, was

separated from the ocean by a berm of sand, and was somewhat stagnant. The distance inland to where it becomes channelized was about 75 yards, and its width was about 20 feet. A tall forest of common ironwood (FACU) grows on either bank, and the banks are covered with thick grass, tentatively identified as seashore paspalum (*Paspalum vaginatum*), a hydrophytic non-native species (FACW). Also in the vicinity were false kamani (*Terminalia catappa*, FAC) and ‘ākulikuli groundcover (FAC). If the site is being considered for development, a complete wetland delineation is suggested.

## DISCUSSION

A recounting of the conservation history of *Manduca blackburni* is an interesting story and reveals that there is still much to learn about the life history and distribution of this endemic sphinx moth, distinguished for becoming the first Hawaiian insect to achieve Federal endangered status in 2000. The moth was first collected by Rev. T. Blackburn near Honolulu, O‘ahu, and was originally described in 1880 by Butler as *Protoparce blackburni*, a species unique to the Hawaiian Islands. The species was subsequently recorded on 6 of the 8 major islands (excluding Ni‘ihau and Lāna‘i), and was considered somewhat widespread and abundant, based on accounts of early European naturalists, mostly from coastal or lowland dry forest habitats receiving less than 50 inches of rain (USFWS 2003). Since 1899, though, taxonomists decided that the species was actually either no different from the tobacco hornworm (now called *Manduca quinquemaculatus*), a widespread New World species, or only an endemic subspecies of it (Riotte 1986).

Historically, *Manduca* appears to have been most common on Maui, with collections in Kahului as far back as 1919, Spreckelsville in 1922, West Maui in 1929, and Wailuku in 1937 (Riotte 1986), but between 1940 and 1970 the moth was recorded statewide only a handful of times, and was presumed extinct after extensive field surveys in the mid-1970s failed to locate any *Manduca* (Rubinoff et al. 2012). During this time, the moth larvae had only been observed feeding on non-native members of the Solanaceae, including tomato, eggplant, and tree tobacco, but in 1984 the larvae were discovered feeding on a rare, endemic tomato relative, ‘aiea (*Nothocestrum latifolium*) in a dry forest on the southwest slope of East Maui. This rediscovery on a new, endemic plant host spurred Riotte (1986) to conduct extensive research and restore the moth’s taxonomic status as a fully recognized species, under the name *Manduca blackburni*. Rubinoff et al. (2012) used molecular

techniques to confirm that *M. blackburni* is a distinct species from the closely related, widespread *M. quinquemaculatus*. The species was subsequently rediscovered on Kaho‘olawe, in the Kanahā-Spreckelsville coastal zone on Maui—both where tree tobacco grows but not *Nothoestrum*—and on the Big Island.

Because of its low population size and the rarity of its newly discovered endemic larval host plant, the U.S. Fish and Wildlife Service (USFWS) made *Manduca blackburni* a priority for listing, and it was federally listed as endangered in 2000. This was followed by USFWS critical habitat designation in 2003. Critical habitats are comprised of specific designated geographic areas that contain those physical or biological features considered essential for the conservation of the species (“primary constituent elements”); these areas may be subject to special management considerations or protection until such time that the species is no longer considered endangered and can be delisted. Following public review of the proposed critical habitat designations for *Manduca*, the USFWS settled on 9 critical habitat units totaling over 55,000 acres on the islands of Moloka‘i, Maui, Kaho‘olawe, and Hawai‘i (USFWS 2003). Two of these critical habitats occur in the survey vicinity.

As originally proposed, the Kanahā Pond—Spreckelsville critical habitat unit totaled 559 acres, stretching along the Kahului coast and including a portion of the DLNR property and the county wastewater treatment plant. The USFWS final ruling settled on two smaller, separate critical habitat units, Kanahā Pond (139 acres) and Kanahā Park (62 acres), a reduction of 358 acres (USFWS 2003). Both sites contain managed native habitats appropriate for *Manduca* conservation. The discarded acreage was considered inessential for the conservation of *Manduca* either because it was found to be more seriously degraded than previously thought, or the primary constituent elements needed by the adults or larvae were not present. As discussed under Objective 1, the USFWS does not consider *Nicotiana glauca* to be a primary constituent element for *Manduca* conservation.

In 2005, the USFWS designated 13 management units on 7 islands totaling over 138,000 acres to aid in the recovery of *Manduca* populations. The selected lands include the best remaining tracts of contiguous habitats suitable for *Manduca* conservation. One unit of 1,184 acres called the Kanahā Pond—Spreckelsville management unit encompasses all of the originally proposed critical habitat in the area (USFWS 2005). This small habitat is considered important for *Manduca* recovery, despite the lack of naturally occurring plants of *Nothoestrum*, primarily as a way station and refuge for the moth populations, which are strong fliers and are believed to be able to fly many kilometers to travel



between their now distantly separated primary habitats. Small, geographically isolated populations can become weaker because of inbreeding depression, but can gain vitality if there is genetic exchange between separated populations. The management unit at Kanahā Pond—Spreckelsville is billed to help bridge the gaps between these separate populations.

It remains uncertain whether *Manduca blackburni* has always inhabited the coastal zone before the arrival of humans to Hawaiian shores. In the Bishop Museum plant collection, there is no documentation of *Nothoestrum*, its preferred host plant, ever having been collected in the coastal zone on any island. If so, which native plants served as hosts for *Manduca* larvae in pre-human times in this habitat? Presently documented larval hosts in this zone are mostly post-Cook introductions, such as commercial tobacco (first collected in 1825), tree tobacco (1864–1865), and tomato (possibly mid-1800s (Wagner et al. 1999)).

In view of the depleted statewide populations of the endemic *Nothoestrum* spp., its preferred host plant, there is some management concern that *Manduca* is shifting its host dependence towards *Nicotiana glauca*, presenting something of a dilemma for land managers preferring to remove the invasive species from their lands. Rubinoff and San Jose (2010) conducted laboratory tests to explore whether alternate native and non-native members of the tomato family (Solanaceae) would serve as acceptable hosts for *Manduca* larvae. In limited trials, they found success using the endemic pōpolo‘aiakeakua (*Solanum sandwicense*), the indigenous pōpolo (*Solanum americanum*), and the non-native tomato (*Lycopersicon esculentum*) and eggplant (*Solanum melongena*) as hosts. This provides some possibilities for land managers hoping to remove the invasive tree tobacco in favor of suitable alternate native or introduced larval host plants.

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## APPENDIX I: Alexander & Baldwin 10-acre parcel plant checklist

Staff from the Bishop Museum, Department of Natural Sciences, on 8–12 December 2013 conducted a biological reconnaissance of 10 acres of industrial-use land adjacent to the Maui Electric Company power plant in the vicinity of Kahului Harbor (Tax Map Keys (2) 3-7-11:17, (2) 3-7-11:23), currently owned by Alexander & Baldwin, Inc., and proposed for acquisition by the State of Hawai‘i Department of Transportation, Harbors Division. The parcel is located in the Kahului Harbor area of north-central Maui in an industrial-use zone, and is bounded on the west by Hobron Lane, on the north by Amala Place, on the east by Amala Road, and to the south (*makai*) by the power plant. In addition, the coastal strip fronting the Maui Electric Company power plant was surveyed.

A total of 65 taxa were noted during the survey, including 5 indigenous (including “ind?”), 1 Polynesian introduction (solely cultivated), 49 naturalized weeds, and 10 cultivated plants. There were no endemic plants noted in the parcel. Four of the 5 native species were found only along the coastal strip: ‘ākulikuli (*Sesuvium portulacastrum*), kīpūkai (*Heliotropium curassavicum*), alena (*Boerhavia repens*), ‘aki‘aki (*Sporobolus virginicus*), while ‘uhaloa (*Waltheria indica*) was found both along the coast and in inland ruderal habitats. None of the 5 naturally occurring native indigenous plants noted in the parcel is a federally protected endangered or threatened species, nor were any wetland habitats noted.

The only spot within the A&B parcel where *Nicotiana glauca* plants were located was in the “notch” parcel (see Map 2); at least one, but possibly several, plants were seen at the base of large tank fenced from access. No GPS point was taken, but Google Earth coordinates place it at N 20.896211, W 156.462755. Seven additional small plants were noted along the coastal strip outside of the A&B parcel (waypoints 934–937 in Appendix IV).

In the A&B parcel, no other members of the Solanaceae that might serve as alternate hosts of *Manduca* larvae were noted. Among adult *Manduca* host plants, no plants of the beach morning-glory (*Ipomoea pes-caprae* subsp. *brasiliensis*) were seen. Two other members of the morning-glory family (*Ipomoea obscura*, *I. triloba*) were noted and may potentially serve as nectar sources for feeding, but both have small corolla tubes relative to the larger beach morning-glory flower. These were infrequent in the survey area. Other documented adult hosts (*Capparis sandwichiana*, *Plumbago zeylanica*, *Nothocestrum latifolium*) were not seen during the survey.

The following is a list of vascular plant species noted during a walk-through survey of the 10-acre Alexander & Baldwin parcel on 8–12 December 2013. In the following table, plants are divided into two main groups, dicots and monocots. Within these groups, plants are arranged alphabetically by family, genus, and species. Each entry includes scientific name with author citation, common name in English and/or Hawaiian (if available), biogeographic status, and presence or absence in the designated parcel. Taxonomy follows Wagner et al. (1999) for native and naturalized plants; Staples and Herbst (2005) for cultivated plants; Palmer (2003) for ferns; and Imada (2012) for current updates of plant names. An explanation of abbreviations used in the list follows.

**Biogeographic Status** (from Wagner et al. 1999)

cult	Cultivated plant; purposefully grown
end	Endemic: native, occurring only in the Hawaiian Archipelago
ind	Indigenous: native, occurring naturally in the archipelago but also outside of Hawai‘i
ind?	Questionably indigenous: probably indigenous, possibly naturalized
nat	Naturalized: introduced to the archipelago directly or indirectly by humans since Western contact and reproducing and spreading vegetatively or by seed
nat?	Questionably naturalized: probably naturalized, but possibly indigenous
pol	Likely introduced during Polynesian migrations, now naturalized

**Parcel**

A&B	Alexander & Baldwin parcel (including “notch”
Coast	Coastal strip makai of Maui Electric Company

**Relative frequency**

c	Common
o	Occasional
r	Rare
1	One-of-a-kind
-	Absent

Scientific name	Common name	Status	Parcel	
			A&B	Coast
<b>DICOTS</b>				
AIZOACEAE (ice plant family)				
Sesuvium portulacastrum (L.) L.	‘ākulikuli, sea purslane	ind	-	x
AMARANTHACEAE (amaranth family)				
Amaranthus spinosus L.	spiny amaranth	nat	x	-
Amaranthus viridis L.	slender amaranth	nat	x	-
APIACEAE (parsley family)				
Centella asiatica (L.) Urb.	Asiatic pennywort	nat	x	-
APOCYNACEAE (dogbane family)				

Scientific name	Common name	Status	Parcel	
			A&B	Coast
<i>Plumeria obtusa</i> L.	Singapore plumeria	cult	x	-
ASTERACEAE (sunflower family)				
<i>Emilia sonchifolia</i> var. <i>javanica</i> (Burm.f.) Mattf.	Flora's paintbrush	nat	x	-
<i>Pluchea carolinensis</i> (Jacq.) G.Don	sourbush, marsh fleabane	nat	x	-
<i>Pluchea indica</i> (L.) Less.	Indian fleabane, Indian pluchea	nat	-	x
<i>Tridax procumbens</i> L.	coat buttons	nat	x	-
<i>Verbesina encelioides</i> (Cav.) Benth. & Hook.	golden crown-beard	nat	x	-
BIGNONIACEAE (catalpa family)				
<i>Tecoma capensis</i> (Thunb.) Lindl.	cape-honeysuckle	cult	x	-
BORAGINACEAE (borage family)				
<i>Cordia sebestena</i> L.	geiger tree, kou haole	cult	x	-
<i>Heliotropium curassavicum</i> L.	kīpūkai, nena	ind	-	x
<i>Heliotropium procumbens</i> Mill. var. <i>depressum</i> (Cham.) Fosberg		nat	x	-
CAPPARACEAE (caper family)				
<i>Cleome gynandra</i> L.	wild spider flower	nat	x	-
CASUARINACEAE (ironwood family)				
<i>Casuarina equisetifolia</i> L.	common ironwood	nat	x	x
CHENOPODIACEAE (goosefoot family)				
<i>Atriplex suberecta</i> I.Verd.	saltbush	nat	x	x
<i>Chenopodium murale</i> L.	goosefoot, pigweed	nat	x	-
CLUSIACEAE (clusia family)				
<i>Clusia rosea</i> Jacq.	autograph tree	nat	x	-
CONVOLVULACEAE (morning-glory family)				
<i>Ipomoea obscura</i> (L.) Ker Gawl.	morning glory	nat	x	-
<i>Ipomoea triloba</i> L.	little bell	nat	x	-
<i>Merremia aegyptia</i> (L.) Urb.	hairy merremia	nat?	-	x
CUCURBITACEAE (gourd family)				
<i>Cucumis dipsaceus</i> Ehrenb. ex Spach	hedgehog gourd, teasel gourd	nat	x	-
EUPHORBIACEAE (euphorbia family)				
<i>Euphorbia hirta</i> L.	hairy spurge, garden spurge	nat	x	-
<i>Euphorbia hypericifolia</i> L.	graceful spurge	nat	x	-
<i>Euphorbia prostrata</i> Aiton	prostrate spurge	nat	x	-
<i>Ricinus communis</i> L.	castor bean	nat	x	-
FABACEAE (bean family)				
<i>Caesalpinia pulcherrima</i> (L.) Sw.	dwarf poinciana	cult	x	-
<i>Crotalaria pallida</i> Aiton	smooth rattlepod	nat	x	-
<i>Desmanthus pernambucanus</i> (L.) Thell.	slender mimosa	nat	x	-
<i>Desmodium tortuosum</i> (Sw.) DC.	Florida beggarweed	nat	x	-
<i>Indigofera spicata</i> Forssk.	creeping indigo	nat	x	-
<i>Leucaena leucocephala</i> (Lam.) de Wit	koa haole	nat	x	x

Scientific name	Common name	Status	Parcel	
			A&B	Coast
<i>Macroptilium lathyroides</i> (L.) Urb.	wild bean, cow pea	nat	x	-
<i>Prosopis pallida</i> (Humb. & Bonpl. ex Willd.) Kunth	algaroba, mesquite, kiawe	nat	x	-
MALVACEAE (hibiscus family)				
<i>Abutilon grandifolium</i> (Willd.) Sweet	hairy abutilon	nat	x	x
<i>Hibiscus rosa-sinensis</i> L.	red hibiscus	cult	x	-
<i>Malva parviflora</i> L.	cheese weed	nat	x	-
<i>Malvastrum coromandelianum</i> (L.) Garcke subsp. <i>coromandelianum</i>	false mallow	nat	x	-
<i>Sida rhombifolia</i> L.		nat?	x	-
MORACEAE (mulberry family)				
<i>Ficus microcarpa</i> L.f.	Chinese banyan	nat	x	-
NYCTAGINACEAE (four-o'clock family)				
<i>Boerhavia coccinea</i> Mill.		nat	x	x
<i>Boerhavia repens</i> L.	alena	ind	-	x
<i>Bougainvillea glabra</i> Choisy	bougainvillea	cult	x	-
PORTULACACEAE (moss-rose family)				
<i>Portulaca oleracea</i> L.	pigweed	nat	x	-
SOLANACEAE (tomato family)				
<i>Nicotiana glauca</i> Graham	tree tobacco	nat	x	x
STERCULIACEAE (cacao family)				
<i>Waltheria indica</i> L.	'uhaloa, hi'aloa	ind?	x	x
ZYGOPHYLLACEAE (lignum-vitae family)				
<i>Tribulus terrestris</i> L.	puncture vine	nat	x	-
<b>MONOCOTS</b>				
ALOEACEAE (aloe family)				
<i>Aloe vera</i> (L.) Burm.f.		cult	x	-
ARECACEAE (palm family)				
<i>Cocos nucifera</i> L.	niu, coconut	pol/cult	x	x
Phoenix hybrid	date palm	nat	x	-
CYPERACEAE (sedge family)				
<i>Cyperus rotundus</i> L.	nut grass	nat	x	-
LILIACEAE (lily family)				
<i>Crinum</i> sp.	spider lily	cult	x	-
POACEAE (grass family)				
<i>Bambusa</i> sp.	bamboo	cult	x	-
<i>Cenchrus ciliaris</i> L.	buffelgrass	nat	x	x
<i>Cenchrus echinatus</i> L.	common sandbur	nat	x	-
<i>Chloris barbata</i> Sw.	swollen fingergrass	nat	x	x
<i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass	nat	x	x
<i>Dactyloctenium aegyptium</i> (L.) Willd.	beach wiregrass	nat	x	-
<i>Eleusine indica</i> (L.) Gaertn.	wiregrass	nat	x	-
<i>Eragrostis pectinacea</i> (Michx.) Nees var.	Carolina lovegrass	nat	x	-

Scientific name	Common name	Status	Parcel	
			A&B	Coast
pectinacea				
<i>Setaria verticillata</i> (L.) P.Beauv.	bristly foxtail	nat	x	-
<i>Sporobolus pyramidatus</i> (Lam.) Hitchc.		nat	x	-
<i>Sporobolus virginicus</i> (L.) Kunth	‘aki‘aki, seashore rushgrass	ind	-	x
<i>Stenotaphrum secundatum</i> (Walter) Kuntze	St. Augustine grass, buffalo grass	cult	x	-



**APPENDIX II: Plant checklist**

The following is a list of vascular plant species noted during a walk-through survey of approximately 32 acres of surveyed land on 8–12 December 2013. A total of 137 taxa were noted during the survey, including 5 endemic (3 of which were solely cultivated), 14 indigenous (including “ind?”), 3 Polynesian introductions (all solely cultivated), 87 naturalized weeds, and 28 cultivated plants.

In the following table, plants are divided into four main groups: dicots, monocots, gymnosperms, and ferns. Within these groups, plants are arranged alphabetically by family, genus, and species. Each entry includes scientific name with author citation, common name in English and/or Hawaiian (if available), biogeographic status, and frequency in designated vegetation zones. Taxonomy follows Wagner et al. (1999) for native and naturalized plants; Staples and Herbst (2005) for cultivated plants; Palmer (2003) for ferns; and Imada (2012) for current updates of plant names. An explanation of abbreviations used in the list follows.

**Biogeographic Status** (from Wagner et al. 1999)

- cult Cultivated plant; purposefully grown
- end Endemic: native, occurring only in the Hawaiian Archipelago
- ind Indigenous: native, occurring naturally in the archipelago but also outside of Hawai‘i
- ind? Questionably indigenous: probably indigenous, possibly naturalized
- nat Naturalized: introduced to the archipelago directly or indirectly by humans since Western contact and reproducing and spreading vegetatively or by seed
- nat? Questionably naturalized: probably naturalized, but possibly indigenous
- pol Likely introduced during Polynesian migrations, now naturalized

**Vegetation zones**

- Cd Coastal dunes
- Cf Coastal forest
- Ri Ruderal & industrial
- Ww Wetlands & waterways

**Relative frequency**

- c Common
- o Occasional
- r Rare
- l One-of-a-kind
- Absent

Scientific name	Common name	Status	Vegetation zones			
			Cd	Cf	Ri	Ww
<b>DICOTS</b>						
AIZOACEAE (ice plant family)						
Sesuvium portulacastrum (L.) L.	‘ākulikuli, sea purslane	ind	o	-	r	o

Scientific name	Common name	Status	Vegetation zones			
			Cd	Cf	Ri	Ww
<i>Sesuvium verrucosum</i> Raf.		nat	-	-	r	-
AMARANTHACEAE (amaranth family)						
<i>Alternanthera pungens</i> Kunth	khaki weed	nat	-	-	r	-
<i>Amaranthus spinosus</i> L.	spiny amaranth	nat	-	-	o	-
<i>Amaranthus viridis</i> L.	slender amaranth	nat	-	-	r	r
ANACARDIACEAE (cashew family)						
<i>Mangifera indica</i> L.	mango	cult	-	-	r	-
<i>Schinus terebinthifolius</i> Raddi	Christmas berry	nat	r	-	r	-
APIACEAE (parsley family)						
<i>Centella asiatica</i> (L.) Urb.	Asiatic pennywort	nat	-	-	r	-
APOCYNACEAE (dogbane family)						
<i>Plumeria obtusa</i> L.	Singapore plumeria	cult	-	-	l	-
<i>Plumeria rubra</i> L.	plumeria	cult	-	-	l	-
ASTERACEAE (sunflower family)						
<i>Bidens pilosa</i> L.	Spanish needle, beggartick	nat	-	-	r	-
<i>Calyptocarpus vialis</i> Less.		nat	-	-	r	-
<i>Conyza bonariensis</i> (L.) Cronquist	hairy horseweed	nat	-	-	r	-
<i>Eclipta prostrata</i> (L.) L.	false daisy	nat	-	-	r	-
<i>Emilia sonchifolia</i> var. <i>javanica</i> (Burm.f.) Mattf.	Flora's paintbrush	nat	-	-	r	-
<i>Flaveria trinervia</i> (Spreng.) C.Mohr		nat	-	-	r	-
<i>Pluchea carolinensis</i> (Jacq.) G.Don	sourbush, marsh fleabane	nat	-	-	o	o
<i>Pluchea indica</i> (L.) Less.	Indian fleabane, Indian pluchea	nat	o	-	r	o
<i>Pluchea x fosbergii</i> Cooperr. & Galang	marsh fleabane	nat	o	o	-	c
<i>Sonchus asper</i> (L.) Hill	prickly sow thistle	nat	-	-	r	-
<i>Sonchus oleraceus</i> L.	sow thistle	nat	-	-	r	-
<i>Synedrella nodiflora</i> (L.) Gaertn.	nodeweed	nat	r	-	r	-
<i>Tridax procumbens</i> L.	coat buttons	nat	-	-	o	-
<i>Verbesina encelioides</i> (Cav.) Benth. & Hook.	golden crown-beard	nat	o	-	o	-
<i>Xanthium strumarium</i> L. var. <i>canadense</i> (Mill.) Torr. & A.Gray	cocklebur	nat	-	-	r	-
BIGNONIACEAE (catalpa family)						
<i>Tecoma capensis</i> (Thunb.) Lindl.	cape-honeysuckle	cult	-	-	l	-
BORAGINACEAE (borage family)						
<i>Cordia sebestena</i> L.	geiger tree, kou haole	cult	-	-	l	-
<i>Heliotropium curassavicum</i> L.	kīpūkai, nena	ind	o	-	o	-
<i>Heliotropium procumbens</i> Mill. var. <i>depressum</i> (Cham.) Fosberg		nat	o	o	c	-
<i>Tournefortia argentea</i> L.f.	tree heliotrope	nat	o	-	r	-
BRASSICACEAE (mustard family)						
<i>Coronopus didymus</i> (L.) Sm.	swinecress	nat	-	-	r	-
CACTACEAE (cactus family)						
<i>Opuntia</i> sp.		cult	-	-	l	-

Scientific name	Common name	Status	Vegetation zones			
			Cd	Cf	Ri	Ww
CAPPARACEAE (caper family)						
<i>Cleome gynandra</i> L.	wild spider flower	nat	-	-	r	-
CARICACEAE (papaya family)						
<i>Carica papaya</i> L.	papaya	cult	-	-	l	-
CARYOPHYLLACEAE (pink family)						
<i>Polycarpon tetraphyllum</i> (L.) L.		nat	-	-	r	-
CASUARINACEAE (ironwood family)						
<i>Casuarina equisetifolia</i> L.	common ironwood	nat	o	c	o	r
CHENOPODIACEAE (goosefoot family)						
<i>Atriplex suberecta</i> I. Verd.	saltbush	nat	c	-	o	-
<i>Chenopodium murale</i> L.	goosefoot, pigweed	nat	o	o	o	-
<i>Chenopodium oahuense</i> (Meyen) Aellen	‘āheahea, ‘āweoweo	end	o	-	o	-
CLUSIACEAE (clusia family)						
<i>Clusia rosea</i> Jacq.	autograph tree	nat	-	-	l	-
COMBRETACEAE (combretum family)						
<i>Terminalia catappa</i> L.	tropical almond, false kamani	nat	-	o	r	r
CONVOLVULACEAE (morning-glory family)						
<i>Ipomoea obscura</i> (L.) Ker Gawl.	morning glory	nat	-	-	r	-
<i>Ipomoea pes-caprae</i> (L.) R.Br.subsp. <i>brasiliensis</i> (L.) Ooststr.	pōhuehue, beach morning glory	ind	c	r	o	-
<i>Ipomoea triloba</i> L.	little bell	nat	-	-	r	-
<i>Jacquemontia sandwicensis</i> A.Gray	pā‘ū-o-Hi‘iaka	end	-	-	r	-
<i>Merremia aegyptia</i> (L.) Urb.	hairy merremia	nat?	-	-	r	-
CUCURBITACEAE (gourd family)						
<i>Cucumis dipsaceus</i> Ehrenb. ex Spach	hedgehog gourd, teasel gourd	nat	-	-	r	-
EUPHORBIACEAE (euphorbia family)						
<i>Codiaeum variegatum</i> (L.) Blume	croton	cult	-	-	l	-
<i>Euphorbia hirta</i> L.	hairy spurge, garden spurge	nat	-	-	o	-
<i>Euphorbia hypericifolia</i> L.	graceful spurge	nat	-	-	r	-
<i>Euphorbia hyssopifolia</i> L.	spurge	nat	-	-	r	-
<i>Euphorbia prostrata</i> Aiton	prostrate spurge	nat	-	-	o	-
<i>Ricinus communis</i> L.	castor bean	nat	-	-	r	-
FABACEAE (bean family)						
<i>Caesalpinia pulcherrima</i> (L.) Sw.	dwarf poinciana	cult	-	-	l	-
<i>Canavalia sericea</i> A.Gray	silky jackbean	nat	o	-	-	-
<i>Crotalaria pallida</i> Aiton	smooth rattlepod	nat	-	-	l	-
<i>Desmanthus pernambucanus</i> (L.) Thell.	slender mimosa	nat	r	-	r	-
<i>Desmodium tortuosum</i> (Sw.) DC.	Florida beggarweed	nat	-	-	r	-
<i>Indigofera spicata</i> Forssk.	creeping indigo	nat	r	-	o	-
<i>Leucaena leucocephala</i> (Lam.) de Wit	koa haole	nat	r	-	o	-
<i>Macroptilium atropurpureum</i> (DC.) Urb.		nat	-	o	c	-
<i>Macroptilium lathyroides</i> (L.) Urb.	wild bean, cow pea	nat	-	-	r	-

Scientific name	Common name	Status	Vegetation zones			
			Cd	Cf	Ri	Ww
<i>Prosopis pallida</i> (Humb. & Bonpl. ex Willd.) Kunth	algaroba, mesquite, kiawe	nat	r	c	r	r
<i>Vigna unguiculata</i> (L.) Verdc.	yard-long bean	cult	-	-	l	-
GOODENIACEAE (naupaka family)						
<i>Scaevola taccada</i> (Gaertn.) Roxb.	naupaka kahakai	ind	c	-	o	-
LAMIACEAE (mint family)						
<i>Leonotis nepetifolia</i> (L.) R.Br.	lion's ear	nat	-	-	r	-
MALVACEAE (hibiscus family)						
<i>Abutilon grandifolium</i> (Willd.) Sweet	hairy abutilon	nat	-	-	r	-
<i>Hibiscus clayi</i> O.Deg. & I.Deg.	aloalo	end/cult	-	-	l	-
<i>Hibiscus rosa-sinensis</i> L.	red hibiscus	cult	-	-	l	-
<i>Hibiscus tiliaceus</i> L.	hau	ind?	-	o	r	-
<i>Malva parviflora</i> L.	cheese weed	nat	r	-	o	-
<i>Malvastrum coromandelianum</i> (L.) Garcke subsp. <i>coromandelianum</i>	false mallow	nat	r	-	r	-
<i>Sida ciliaris</i> L.		nat	-	-	o	-
<i>Sida rhombifolia</i> L.		nat?	-	-	r	-
<i>Thespesia populnea</i> (L.) Sol. ex Corrêa	milo	ind?	o	o	-	o
MORACEAE (mulberry family)						
<i>Ficus microcarpa</i> L.f.	Chinese banyan	nat	-	-	r	-
MYOPORACEAE (naio family)						
<i>Myoporum sandwicense</i> A.Gray	naio	ind	r	-	-	-
NYCTAGINACEAE (four-o'clock family)						
<i>Boerhavia coccinea</i> Mill.		nat	r	-	o	-
<i>Boerhavia repens</i> L.	alena	ind	o	-	-	-
<i>Bougainvillea glabra</i> Choisy	bougainvillea	cult	-	-	l	-
PAPAVERACEAE (poppy family)						
<i>Argemone mexicana</i> L.	Mexican poppy	nat	r	-	-	-
POLYGONACEAE (buckwheat family)						
<i>Coccoloba uvifera</i> (L.) L.	sea grape	nat	-	r	r	-
PORTULACACEAE (moss-rose family)						
<i>Portulaca oleracea</i> L.	pigweed	nat	r	-	l	r
RUBIACEAE (coffee family)						
<i>Morinda citrifolia</i> L.	noni, Indian mulberry	pol/cult	-	-	l	-
RUTACEAE (citrus family)						
<i>Citrus aurantiifolia</i> (Christm.) Swingle	lime	cult	-	-	l	-
<i>Citrus</i> sp.		cult	-	-	l	-
SCROPHULARIACEAE (snapdragon family)						
<i>Bacopa monnieri</i> (L.) Wettst.	'ae'ae	ind	-	-	-	o
SOLANACEAE (tomato family)						
<i>Datura stramonium</i> L.	jimson weed	nat	-	-	l	-
<i>Nicotiana glauca</i> Graham	tree tobacco	nat	o	r	c	-
<i>Physalis angulata</i> L.	groundcherry	nat	-	-	r	-

Scientific name	Common name	Status	Vegetation zones			
			Cd	Cf	Ri	Ww
<i>Solanum americanum</i> Mill.	glossy nightshade, pōpolo	ind?	r	-	-	-
STERCULIACEAE (cacao family)						
<i>Waltheria indica</i> L.	‘uhaloa, hi‘aloha	ind?	r	o	c	-
THYMELAEACEAE (‘akia family)						
<i>Wikstroemia uva-ursi</i> A.Gray var. <i>uva-ursi</i>	‘ākia	end/cult	-	-	1	-
VERBENACEAE (verbena family)						
<i>Vitex trifolia</i> L.		nat	-	-	r	-
ZYGOPHYLLACEAE (lignum-vitae family)						
<i>Tribulus terrestris</i> L.	puncture vine	nat	-	-	r	-
<b>MONOCOTS</b>						
AGAVACEAE (agave family)						
<i>Cordyline fruticosa</i> (L.) A.Chev.	kī, ti	pol/cult	-	-	1	-
ALOEACEAE (aloe family)						
<i>Aloe vera</i> (L.) Burm.f.		cult	-	-	1	-
ARACEAE (aroid family)						
<i>Xanthosoma robustum</i> Schott	‘ape	cult	-	-	1	-
ARECACEAE (palm family)						
<i>Cocos nucifera</i> L.	niu, coconut	pol/cult	-	-	o	-
<i>Dyopsis lutescens</i> (H.Wendl.) Beentje & J.Dransf.	areca palm	cult	-	-	1	-
<i>Hyophorbe lagenicaulis</i> (L.H.Bailey) H.E.Moore	bottle palm	cult	-	-	1	-
Phoenix hybrid	date palm	nat	-	o	-	r
<i>Pritchardia thurstonii</i> F.Muell. & Drude		cult	-	-	1	-
<i>Pritchardia</i> sp.	loulu	end/cult	-	-	1	-
<i>Thrinax radiata</i> J.A.Schultes & J.H.Schultes	thatch palm	cult	-	-	1	-
<i>Vietchia merrillii</i> (Becc.) H.E.Moore	Manila palm	cult	-	-	1	-
<i>Washingtonia</i> sp.		cult	-	-	-	1
BROMELIACEAE (bromeliad family)						
<i>Ananas comosus</i> (L.) Merr.	pineapple	cult	-	-	1	-
CYPERACEAE (sedge family)						
<i>Bolboschoenus maritimus</i> (L.) Palla subsp. <i>paludosus</i> (A.Nelson) T.Koyama	makai, kaluhā	ind	-	-	-	o
<i>Cyperus laevigatus</i> L.	makaloa	ind	-	-	-	o
<i>Cyperus rotundus</i> L.	nut grass	nat	-	-	o	-
<i>Schoenoplectus californicus</i> (C.A.Mey.) Palla	kaluhā	nat?	-	-	-	c
LEMNACEAE (duckweed family)						
<i>Landoltia punctata</i> (G.Mey.) Les & D.J.Crawford		nat	-	-	-	o
LILIACEAE (lily family)						
<i>Allium fistulosum</i> L.	green onion	cult	-	-	1	-
<i>Crinum</i> sp.	spider lily	cult	-	-	1	-
POACEAE (grass family)						
<i>Bambusa</i> sp.	bamboo	cult	-	-	1	-
<i>Cenchrus ciliaris</i> L.	buffelgrass	nat	o	o	c	-

Scientific name	Common name	Status	Vegetation zones			
			Cd	Cf	Ri	Ww
<i>Cenchrus echinatus</i> L.	common sandbur	nat	-	-	r	-
<i>Chloris barbata</i> Sw.	swollen fingergrass	nat	r	o	c	r
<i>Chloris divaricata</i> R.Br. var. <i>divaricata</i>	stargrass	nat	-	-	r	-
<i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass	nat	o	-	o	o
<i>Cynodon nlemfuensis</i> Vanderyst		nat	-	-	r	-
<i>Dactyloctenium aegyptium</i> (L.) Willd.	beach wiregrass	nat	r	-	o	-
<i>Digitaria ciliaris</i> (Retz.) Koeler	Henry's crabgrass	nat	-	o	r	-
<i>Eleusine indica</i> (L.) Gaertn.	wiregrass	nat	-	-	-	r
<i>Eragrostis amabilis</i> (L.) Wight & Arn.	lovegrass	nat	r	-	-	r
<i>Eragrostis pectinacea</i> (Michx.) Nees var. <i>pectinacea</i>	Carolina lovegrass	nat	-	-	o	-
<i>Panicum repens</i> L.	torpedo grass	nat	-	-	-	o
<i>Paspalum vaginatum</i> Sw.	seashore paspalum	nat	-	-	-	o
<i>Setaria verticillata</i> (L.) P.Beauv.	bristly foxtail	nat	-	-	r	-
<i>Sporobolus pyramidatus</i> (Lam.) Hitchc.		nat	-	r	o	-
<i>Sporobolus virginicus</i> (L.) Kunth	'aki'aki, seashore rushgrass	ind	c	-	r	r
<i>Stenotaphrum secundatum</i> (Walter) Kuntze	St. Augustine grass, buffalo grass	cult	-	-	l	-
<i>Urochloa distachya</i> (L.) T.Q.Nguyen		nat	r	-	-	-
<i>Urochloa maxima</i> (Jacq.) R.D.Webster	Guinea grass	nat	-	o	o	-
<b>GYMNOSPERMS</b>						
CYCADACEAE (cycad family)						
<i>Cycas revoluta</i> Thunb.	Japanese sago-palm	cult	-	-	l	-
<b>FERNS</b>						
NEPHROLEPIDACEAE (Boston fern family)						
<i>Nephrolepis brownii</i> (Desv.) Hovenkamp & Miyam.		nat	-	-	l	-

**APPENDIX III: Arthropod checklist**

The following is a list of arthropods found during a 5-day survey conducted in the Kahului Harbor area. A total of 58 species were collected while searching on and near the alien tree tobacco (*Nicotiana glauca*).

NAME	STATUS IN HAWAII	INCIDENCE
<b>ARACHNIDA: ARANEAE (Spiders)</b>		
<b>Araneidae</b>		
<i>Argiope appensa</i> (Walckenaer 1841) yellow garden spider	adv	Common
<i>Gasteracantha mammosa</i> C.L. Koch 1844 Asian spinybacked spider	adv	Common
<b>Oxyopidae</b>		
<i>Oxyopes</i> sp. A [Kumashiro et. al. 1990] lynx spider	adv	Common
<b>Salticidae</b>		
<i>Hasarius adansoni</i> (Audouin 1826)	adv	Local
<b>BLATTODEA (Cockroaches)</b>		
<b>Blaberidae</b>		
<i>Pycnoscelus indicus</i> (Fabricius 1775) Surinam cockroach	adv	Common
<b>Blatellidae</b>		
<i>Blatella lituricollis</i> (Walker 1868) false German cockroach	adv	Common
<b>INSECTA: COLEOPTERA (Beetles)</b>		
<b>Anthicidae (ant-like flower beetles)</b>		
<i>Anthicus recens</i> Werner 1967	adv	Local
<b>Chrysomelidae</b>		
<i>Diachus auratus</i> (Fabricius 1801)	adv	Common
<i>Lema trilinea</i> White 1981	adv	Scarce
<i>Stator pruininus</i> (Horn 1873) pruinose bean weevil	adv	Common
<b>Coccinellidae</b>		
<i>Coelophora inaequalis</i> (Fabricius 1775) Common Australian lady beetle	pur	Local
<i>Diomus notesens</i> (Blackburn 1889)	pur	Local
<b>Curculionidae</b>		
<i>Lixus mastersi</i> Pascoe 1874	adv	Local
<b>Hydrophilidae</b>		
<i>Tropisternus salsamentus</i> Fall 1901	adv	Common wetland species

NAME	STATUS IN HAWAII	INCIDENCE
<b>Scarabaeidae</b>		
<i>Protaetia fusca</i> (Herbst 1790) mango flower beetle	adv	Common
<b>Tenebrionidae</b>		
<i>Ammophorus insularis</i> (Boheman 1858)	adv	Common
<b>INSECTA: DIPTERA (True flies)</b>		
<b>Agromyzidae</b>		
<i>Pseudapomyza spicata</i> (Malloch)	adv	Local
<b>Anthomyidae</b>		
<i>Anthomyia vicarians</i> Schiner 1868	adv	Common
<b>Chironomidae</b>		
<i>Chironomus</i> sp.	unk	Local
<b>Chloropidae</b>		
<i>Monochaetoscinella anonyma</i> (Williston, 1896)	adv	Local
<b>Dolichopodidae</b>		
<i>Chrysosoma globiferum</i> (Wiedemann 1830)	adv	Common
<i>Dolichopus exsul</i> Aldrich 1922	adv	Common
<b>Ephydriidae</b>		
<i>Ceropsilopa coquilletti</i> Cresson, 1922	adv	Local
<i>Clasiopella uncinata</i> Hendel, 1914	adv	Local
<i>Psilopa girschneri</i> Von Roeder, 1889	adv	Local
<i>Scatella hawaiiensis</i> (Grinshaw)	end	Common
<i>Scatella sexnotata</i> (Cresson)	ind	Common
<b>Muscidae</b>		
<i>Atherigona orientalis</i> Schiner 1868	adv	Common
<b>Syrphidae</b>		
<i>Eristalinus aeneus</i> (Scopoli 1763)	adv	Common
<b>INSECTA: HEMIPTERA: HETEROPTERA (True bugs)</b>		
<b>Corixidae</b>		
<i>Trichocorixa reticulata</i> (Guerin-Meneville 1857)	adv	Local
<b>Lygaeidae</b>		
<i>Pseudopachybrachius vinctus</i> (Say 1832)	adv	Common
<b>Miridae</b>		
<i>Coridromus variegatus</i> (Montrouzier 1861)	adv	Common
<i>Trigonotylus tenuis</i> (Reuter 1895)	adv	Common
<b>Nabidae</b>		
<i>Nabis capsiformis</i> (Germar 1837)	adv	Uncommon



NAME	STATUS IN HAWAII	INCIDENCE
<b>Pentatomidae</b>		
<i>Eysarcoris ventralis</i> (Westwood 1837)	adv	Common
<b>Reduviidae</b>		
<i>Zelus renardii</i> Kolenati 1856	adv	Local
<b>Tingidae</b>		
<i>Corythucha morrilli</i> Osborn & Drake 1917	adv	Local
<i>Leptodictya tabida</i> (Herrich-Schaeffer 1840)	adv	Common
<b>INSECTA: HEMIPTERA: HOMOPTERA</b> (Hoppers, scales & relatives)		
<b>Cicadellidae</b>		
<i>Balclutha incisa hospes</i> (Kirkaldy 1910)	adv	Common
<i>Carneocephala sagittifera</i> (Uhler 1895)	adv	Common
<i>Empoasca solana</i> DeLong 1931	adv	Common
<i>Spanbergiella quadripunctata</i> Lawson 1932	adv	Common
<b>Delphacidae</b>		
<i>Sardia rostrata pluto</i> (Kirkaldy 1906)	adv	Common
<b>Flatidae</b>		
<i>Melormenis basalis</i> (Walker 1851)	adv	Common
<b>Margarodidae</b>		
<i>Icerya purchasi</i> Maskell 1878 cottony cushion scale	adv	Common
<b>INSECTA: HYMENOPTERA (Bees &amp; wasps)</b>		
<b>Apidae</b>		
<i>Apis mellifera</i> Linnaeus 1758	adv	Common
<b>Ichneumonidae</b>		
<i>Casinaria infesta</i> (Cresson 1872)	adv	Common
<i>Diplazon laetatorius</i> (Fabricius 1781)	adv	Common
<b>Sphecidae</b>		
<i>Sceliphron caementarium</i> (Drury 1770)	adv	Local
<b>Vespidae</b>		
<i>Polistes aurifer</i> Saussure 1853	adv	Local
<b>INSECTA: LEPIDOPTERA (Moths &amp; butterflies)</b>		
<b>Lycaenidae</b>		
<i>Brephidium exilis</i> (Boisduval 1852)	adv	Common
<i>Lampides boeticus</i> (Linnaeus 1767)	adv	Common
<b>Nymphalidae</b>		
<i>Danaus plexippus</i> (Linnaeus 1758)	adv	Common

NAME	STATUS IN HAWAII	INCIDENCE
<b>INSECTA: MANTODEA</b> (Praying mantis)		
<b>Mantidae</b>		
<i>Hierodula patellifera</i> (Serville 1839)	adv	Local
<b>INSECTA: ODONATA</b> (Dragonflies & damselflies)		
<b>Coenagrionidae</b>		
<i>Ischnura ramburii</i> (Selys-Longchamps 1850)	adv	Common
<b>Libellulidae</b>		
<i>Orthemis ferruginea</i> (Fabricius 1775)	adv	Local
<i>Pantala flavescens</i> (Fabricius 1798)	adv	Common
<b>INSECTA: ORTHOPTERA</b> (Grasshoppers, crickets & katydids)		
<b>Acrididae</b>		
<i>Oedaleus abruptus</i> (Thunberg 1815)	adv	Common
<b>Pyrgomorohidae</b>		
<i>Atractomorpha sinensis</i> Bolivar 1905	adv	Common
<b>CRUSTACEA: ISOPODA</b> (Pillbugs & sowbugs)		
<i>Porcellio laevis</i> Latreille 1804	adv	Common

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1 = Names and arrangement follow Nishida (2002).

2 = Biogeographic Status: end=endemic to HIs, ind=indigenous to HIs, adv=adventive, pur=purposefully introduced.

3 = Incidence: .A subjective measure of commonness within the Kahului Harbor area environs.

**APPENDIX IV: Bird and feral mammal checklist**

The following is a list of 12 birds and a single feral mammal observed during a 5-day survey conducted in the Kahului Harbor area. The record for Axis deer was made on the observation of multiple deer tracks along the southern boundary chain-link fence outside the Kahului wastewater treatment plant (Fig. 4, p. 46). No endangered or threatened bird species were observed in the areas surveyed.

<b>NAME</b>	<b>STATUS IN HAWAII</b>	<b>INCIDENCE</b>
<b>AVES:</b>		
<b>PHASIANIDAE</b>		
<i>Francolinus pondicerianus</i> Grey Francolin	N	Local
<b>ARDEIDAE</b>		
<i>Bubulcus virescens</i> Cattle Egret	V, N	Local
<i>Nycticorax nycticorax</i> Black-crowned Night-Heron	R (Indigenous)	Uncommon
<b>CHARADRIIDAE</b>		
<i>Pluvialis fulva</i> Pacific Golden-Plover	W	Local
<b>SCOLOPACIDAE</b>		
<i>Tringa incana</i> Wandering Tattler	W	Uncommon
<b>COLUMBIDAE</b>		
<i>Streptopelia chinensis</i> Spotted Dove	N	Common
<i>Geopelia striata</i> Zebra Dove	N	Common
<b>ZOSTROPIDAE</b>		
<i>Zosterops japonicus</i> Japanese White-eye	N	Common
<b>STURNIDAE</b>		
<i>Acridotheres tristis</i> Common Myna	N	Common
<b>EMBERIZIDAE</b>		
<i>Paroaria coronata</i> Red-crested Cardinal	N	Local
<b>PASSERIDAE</b>		
<i>Passer domesticus</i> House Sparrow	N	Common

NAME	STATUS IN HAWAII	INCIDENCE
<b>ESTRILIDAE</b>		
<i>Padda oryzivora</i> Java Sparrow	N	Common
<b>MAMMALIA:</b>		
<b>ARTIODACTYLA: CERVIDAE</b>		
<i>Axis axis</i> Chital deer, Spotted deer, Axis deer	N	Local

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Names follow Pyle and Pyle (2009) <<http://hbs.bishopmuseum.org/birds/rlp-monograph/PrimaryChecklist.htm>>

R = Resident (Endemic or Indigenous)

N = Naturalized (non-native) resident (established and breeding)

W = Winter resident (some may migrate through the islands)

**APPENDIX V: Selected GPS localities (WGS 84 datum, maximum error 4m)**

Site abbreviations: A&B (Alexander & Baldwin); DLNR (State Department of Land and Natural Resources); MECO (Maui Electric Company); WTP (Maui County Wastewater Treatment Plant)

***Nicotiana glauca* waypoints**

Waypt#	Date	Coordinate	Notes
none	09-DEC-13	None taken	1+ plants in “notch” parcel, A&B
855	09-DEC-13	N20.89588 W156.45381	1 plant, WTP
857	09-DEC-13	N20.89589 W156.45375	1 plant, WTP
858	09-DEC-13	N20.89592 W156.45372	1 plant, 12 ft tall, WTP
864	09-DEC-13	N20.89679 W156.45483	1 plant, WTP
866	09-DEC-13	N20.89655 W156.45516	1 plant, WTP
867	09-DEC-13	N20.89688 W156.45634	1 plant, 10 ft tall, WTP
868	09-DEC-13	N20.89693 W156.45690	1 plant, WTP
870	09-DEC-13	N20.89672 W156.45732	1 plant, WTP
871	09-DEC-13	N20.89651 W156.45787	6 plants, WTP
873	09-DEC-13	N20.89615 W156.45813	1 plant, 6 ft tall, WTP
874	09-DEC-13	N20.89607 W156.45784	2 plants, WTP
875	09-DEC-13	N20.89594 W156.45789	2 plants, WTP
877	09-DEC-13	N20.89585 W156.45754	1 plant, WTP
878	09-DEC-13	N20.89575 W156.45748	2 plants, WTP
879	09-DEC-13	N20.89574 W156.45740	6+ plants, WTP
880	09-DEC-13	N20.89567 W156.45734	4+ plants, WTP
883	09-DEC-13	N20.89576 W156.45729	1 plant, WTP
884	09-DEC-13	N20.89585 W156.45732	1 plant, WTP
885	09-DEC-13	N20.89587 W156.45738	6 plants, WTP
886	09-DEC-13	N20.89604 W156.45738	1 plant, WTP
887	09-DEC-13	N20.89539 W156.45784	1 plant, WTP
888	09-DEC-13	N20.89540 W156.45800	2 plants, WTP
893	10-DEC-13	N20.89679 W156.45478	11+ plants, WTP
895	10-DEC-13	N20.89687 W156.45636	1 plant, WTP
897	10-DEC-13	N20.89693 W156.45687	3 plants, WTP
934	10-DEC-13	N20.89695 W156.46149	4 plants, MECO
935	10-DEC-13	N20.89707 W156.46155	1 plant, MECO
936	10-DEC-13	N20.89715 W156.46259	1 plant, MECO
937	10-DEC-13	N20.89714 W156.46271	1 plant, MECO
942	10-DEC-13	N20.89532 W156.45803	10+ plants, DLNR
943	11-DEC-13	N20.89629 W156.45732	6+ plants, WTP
944	11-DEC-13	N20.89614 W156.45731	6+ plants, WTP
945	11-DEC-13	N20.89609 W156.45772	1 plant, WTP

***Ipomoea pes-caprae* subsp. *brasiliensis* waypoints**

Waypt#	Date	Coordinate	Notes
860	09-DEC-13	N20.89603 W156.45373	east end, WTP
861	09-DEC-13	N20.89627 W156.45379	east end, WTP
869	09-DEC-13	N20.89691 W156.45710	NE corner, WTP
872	09-DEC-13	N20.89638 W156.45814	NW corner, WTP
890	10-DEC-13	N20.89599 W156.45365	outside east end, WTP
894	10-DEC-13	N20.89668 W156.45556	outside coast fence, WTP
928	10-DEC-13	N20.89712 W156.45867	scattered on dunes, DLNR
930	10-DEC-13	N20.89709 W156.46012	on beach, DLNR

***Datura stramonium* waypoint**

Waypt#	Date	Coordinate	Notes
876	09-DEC-13	N20.89591 W156.45781	2 plants, 18 inches tall, WTP

**Wetland perimeter, DLNR property**

Waypt#	Date	Coordinate	Notes
901	10-DEC-13	N20.89679 W156.45832	wetland perimeter, clockwise
902	10-DEC-13	N20.89674 W156.45832	wetland perimeter
903	10-DEC-13	N20.89669 W156.45833	wetland perimeter
904	10-DEC-13	N20.89664 W156.45834	wetland perimeter
905	10-DEC-13	N20.89660 W156.45836	wetland perimeter
906	10-DEC-13	N20.89658 W156.45840	wetland perimeter
907	10-DEC-13	N20.89659 W156.45845	wetland perimeter
908	10-DEC-13	N20.89657 W156.45851	wetland perimeter
909	10-DEC-13	N20.89658 W156.45857	wetland perimeter
910	10-DEC-13	N20.89660 W156.45861	wetland perimeter
911	10-DEC-13	N20.89660 W156.45866	wetland perimeter
912	10-DEC-13	N20.89659 W156.45869	wetland perimeter
913	10-DEC-13	N20.89667 W156.45872	wetland perimeter
914	10-DEC-13	N20.89669 W156.45872	wetland perimeter
915	10-DEC-13	N20.89672 W156.45869	wetland perimeter
916	10-DEC-13	N20.89675 W156.45867	wetland perimeter
917	10-DEC-13	N20.89677 W156.45861	wetland perimeter
918	10-DEC-13	N20.89677 W156.45858	wetland perimeter
919	10-DEC-13	N20.89680 W156.45854	wetland perimeter
920	10-DEC-13	N20.89682 W156.45851	wetland perimeter
921	10-DEC-13	N20.89684 W156.45846	wetland perimeter
922	10-DEC-13	N20.89684 W156.45840	wetland perimeter
923	10-DEC-13	N20.89682 W156.45836	wetland perimeter
924	10-DEC-13	N20.89682 W156.45832	wetland perimeter
925	10-DEC-13	N20.89678 W156.45830	wetland perimeter

**Mau'oni Pond waypoints, DLNR property**

Waypt#	Date	Coordinate	Notes
940	10-DEC-13	N20.89550 W156.46055	west bank
971	11-DEC-13	N20.89513 W156.45939	east bank, mauka end
972	11-DEC-13	N20.89537 W156.45925	east bank
973	11-DEC-13	N20.89551 W156.45932	east bank
974	11-DEC-13	N20.89564 W156.45928	east bank
976	11-DEC-13	N20.89587 W156.45942	east bank
977	11-DEC-13	N20.89599 W156.45945	east bank

**Mau'oni Pond waypoints, DLNR property (cont.)**

Waypt#	Date	Coordinate	Notes
978	11-DEC-13	N20.89610 W156.45950	east bank
979	11-DEC-13	N20.89629 W156.45956	east bank
980	11-DEC-13	N20.89646 W156.45956	east bank
981	11-DEC-13	N20.89664 W156.45964	east bank
982	11-DEC-13	N20.89670 W156.45971	east bank
983	11-DEC-13	N20.89685 W156.45973	east bank, <i>makai</i> end

**Drainage channel, DLNR property**

Waypt#	Date	Coordinate	Notes
948	11-DEC-13	N20.89513 W156.45866	east end of Amala Place bridge
949	11-DEC-13	N20.89512 W156.45871	west end of Amala Place bridge
950	11-DEC-13	N20.89526 W156.45880	west bank, <i>mauka</i> end
951	11-DEC-13	N20.89537 W156.45885	west bank
952	11-DEC-13	N20.89552 W156.45891	west bank
953	11-DEC-13	N20.89574 W156.45899	west bank
954	11-DEC-13	N20.89592 W156.45907	west bank
955	11-DEC-13	N20.89611 W156.45913	west bank
956	11-DEC-13	N20.89622 W156.45918	west bank
957	11-DEC-13	N20.89640 W156.45923	west bank
958	11-DEC-13	N20.89663 W156.45927	west bank, <i>makai</i> end

**Water-filled depression A, DLNR property**







Waypt#	Date	Coordinate	Notes
959	11-DEC-13	N20.89564 W156.45903	Pond perimeter, clockwise
960	11-DEC-13	N20.89560 W156.45905	Pond perimeter
961	11-DEC-13	N20.89554 W156.45903	Pond perimeter
962	11-DEC-13	N20.89546 W156.45900	Pond perimeter
963	11-DEC-13	N20.89541 W156.45900	Pond perimeter
964	11-DEC-13	N20.89540 W156.45901	Pond perimeter
965	11-DEC-13	N20.89542 W156.45902	Pond perimeter
966	11-DEC-13	N20.89545 W156.45905	Pond perimeter
967	11-DEC-13	N20.89549 W156.45907	Pond perimeter
968	11-DEC-13	N20.89553 W156.45909	Pond perimeter
969	11-DEC-13	N20.89557 W156.45908	Pond perimeter
970	11-DEC-13	N20.89559 W156.45908	Pond perimeter

**Water-filled depression B, DLNR property**

Waypt#	Date	Coordinate	Notes
985	11-DEC-13	N20.89565 W156.45907	Pond perimeter, clockwise
986	11-DEC-13	N20.89568 W156.45911	Pond perimeter
987	11-DEC-13	N20.89571 W156.45917	Pond perimeter
988	11-DEC-13	N20.89574 W156.45917	Pond perimeter
989	11-DEC-13	N20.89578 W156.45918	Pond perimeter
990	11-DEC-13	N20.89578 W156.45912	Pond perimeter
991	11-DEC-13	N20.89575 W156.45911	Pond perimeter
992	11-DEC-13	N20.89571 W156.45908	Pond perimeter
993	11-DEC-13	N20.89566 W156.45907	Pond perimeter

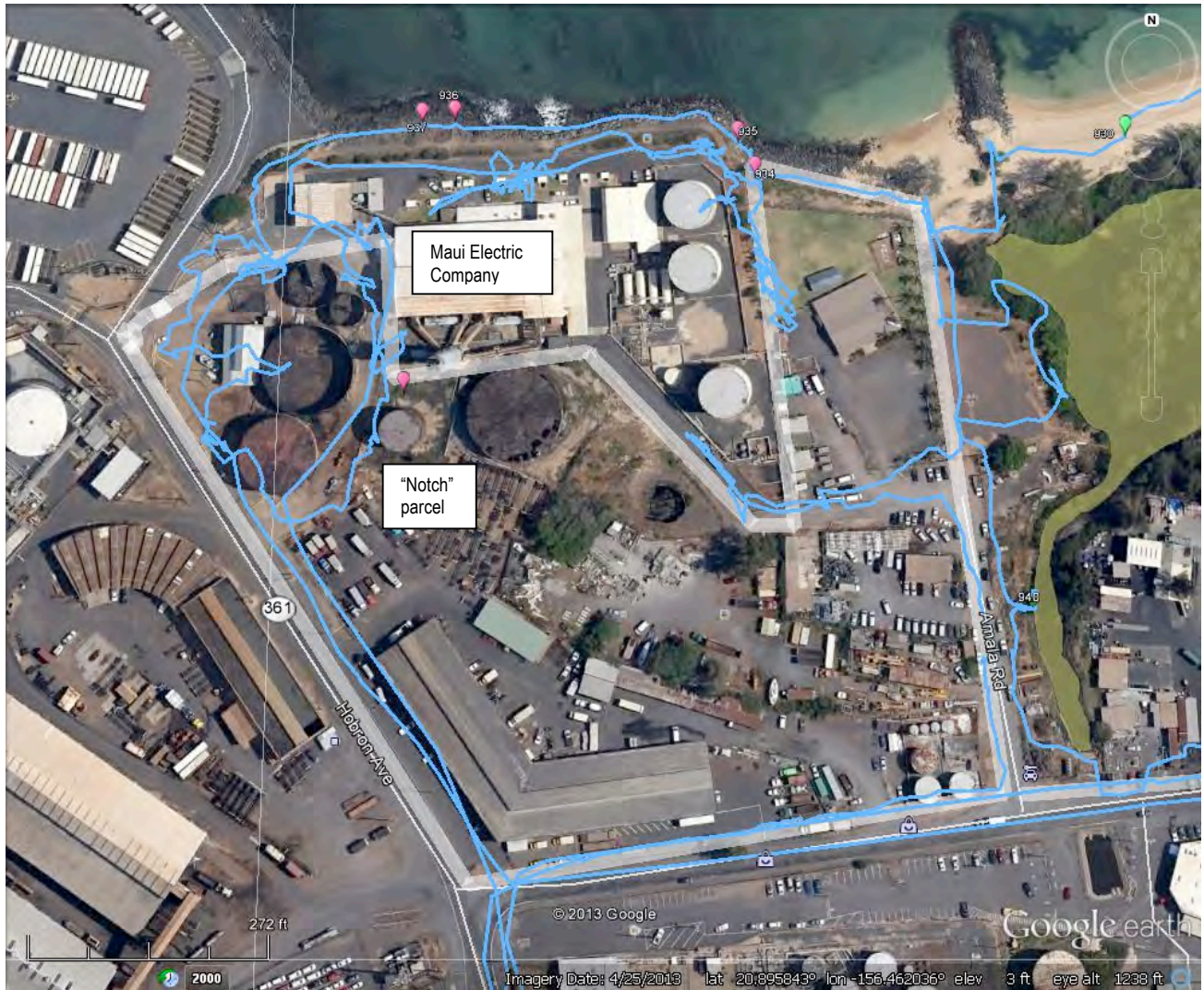
**APPENDIX VI: Tracks and points of interest**  
**Map 1. Kahului Harbor, overall view of survey area.**







- |   |                       |   |   |
|---|-----------------------|---|---|
|  | Property boundary     |  | Tree tobacco ( <i>Nicotiana glauca</i> ) locality                                     |
|  | Survey track          |  | Beach morning-glory ( <i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i> ) locality |
|  | Water feature/wetland |  | Jimson weed ( <i>Datura stramonium</i> )  |



**MAP 2. Alexander & Baldwin property (10 acres)**



-  Tree tobacco (*Nicotiana glauca*) locality
-  Beach morning-glory (*Ipomoea pes-caprae* subsp. *brasiliensis*) locality
-  Survey track
-  Property boundary

**MAP 3. DLNR property**



- Tree tobacco (*Nicotiana glauca*) locality
- Beach morning-glory (*Ipomoea pes-caprae* subsp. *brasiliensis*) locality
- Jimson weed (*Datura stramonium*)
- Property boundary
- Survey track
- Water feature/wetland



Map 4. Maui County Wastewater Treatment Plant.



- Tree tobacco (*Nicotiana glauca*) locality
- Beach morning-glory (*Ipomoea pes-caprae* subsp. *brasiliensis*) locality
- Jimson weed (*Datura stramonium*)
- Survey track
- Property boundary

MAP 5. State Harbors Division property, Pier 2.



-  Survey track
-  Water feature/wetland

**APPENDIX VII: Photographs**

**Figure 1. Chrysomelid beetle feeding damage on *Nicotiana glauca*.** Photo by D.J. Preston, HBS.



**Figure 2. Chrysomelid feeding damage on *Datura stramonium*.** Photo by D.J. Preston, HBS.



**Figure 3. Sphinx moth feeding damage on *Nicotiana glauca*.** Photo by D.J. Preston, HBS.



**Figure 4. Axis deer tracks observed outside the Kahului wastewater treatment plant.** Photo by D.J. Preston, HBS.







**Figure 5. Tree tobacco (*Nicotiana glauca*).** Photo by C. Imada, HBS.



**Figure 6. Beach morning-glory (*Ipomoea pes-caprae* subsp. *brasiliensis*).** Photo by C. Imada, HBS.



**Figure 7. Wetland on DLNR property, backed by dump area and coastal forest zone.** Photo by C. Imada, HBS.



**Figure 8. Coastal dune habitat, makai of wastewater treatment plant.** Photo by C. Imada, HBS.



**Figure 9. Ruderal/industrial vegetation type, makai of wastewater plant settling pond.** Photo by C. Imada, HBS.



**Figure 10. Drainage channel on DLNR property. The *makai* end in the distance is blocked from the ocean by a sandbar.** Photo by C. Imada, HBS.



**Figure 11. Water-filled depression A on DLNR property.** Photo by C. Imada, HBS.



**Figure 12. Mau'oni Pond on DLNR property, with coastal forest and patches of wetland vegetation on flat sections of pond bank.** Photo by C. Imada, HBS.



**Figure 13. Drainage channel west of Pier 2.**  
Photo by D.J. Preston, HBS.