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Assessing the presence and distribution of 23 Hawaiian yellow-faced bee species on lands adjacent to military installations on O'ahu and Hawai'i Island

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The Hawaii-Pacific Islands Cooperative Ecosystem Studies Unit is a coalition of governmental agencies, non-governmental organizations and universities that promotes research, education and technical assistance to support better stewardship of imperiled natural and cultural resources within the Pacific.

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Hylaeus anthracinus on flower of *Heliotropium foertherianum*

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Abstract

The endemic *Hylaeus* bees are critical pollinators in native ecosystems in Hawai‘i. Seven species are proposed for listing as endangered, and many more are rare and potentially endangered. We surveyed 40 localities on O‘ahu, 56 on Hawai‘i, and approximately 70 km of the coastline of Hawai‘i for 23 species of native *Hylaeus*, including four added during the course of the project. All of the native *Hylaeus* were much rarer than they were during previous surveys in 1999–2002, including many previously considered common. The only target species found in significant numbers was *H. anthracinus*, which is restricted to narrow strips of seashore vegetation on both islands but can occur in high density where present. However, the largest O‘ahu population, at Ka‘ena Point, appears to have completely disappeared since it was last observed in 2002. Significant populations exist on Hawai‘i, but only two sites are currently known on O‘ahu. Six of the other species on O‘ahu were not seen at all, and the remaining six (*H. anomalus*, *H. laetus*, *H. makaha*, *H. mamo*, *H. mana*, and *H. mimicus*) were collected once or twice and/or with a total of 1–5 individuals each. On Hawai‘i, only *H. flavipes*, *H. kona*, *H. laetus*, *H. ombrias*, and *H. rugulosus* were collected, mainly from in or around Pōhakuloa Training Area during a brief period of July and August. Most non-target species have been found at least once, but nearly all in low numbers; some of the less common ones, including *H. setosifrons* on Hawai‘i, were extremely rare or absent. The past several years have been extremely dry on the leeward sides of the islands, where most of the rare species occur, and drought may be a factor in the low numbers of bees. Serious damage and mortality among *Myoporum sandwicense*, an important floral resource, as a result of thrips infestation may also be important in reducing numbers and diversity of bees in montane areas of Hawai‘i. These results indicate that management of *Hylaeus* for recovery will be difficult, particularly at montane sites, but that the conservation need is also increasingly urgent as invasive species and climate change are having a greater and more rapid impact than anticipated. In coastal sites, the alien tree *Heliotropium foertherianum* (=*Tournefortia argentea*, tree heliotrope) is a critical floral resource for *Hylaeus* and should be managed with careful regard for impacts on bee populations.

Background

The Hawaiian Islands

Hawai‘i is frequently referred to as the “endangered species capital of the world,” and it is unquestionably the center of endangered species in the United States. Of the 1406 species currently listed as threatened or endangered, 375 are endemic to the Hawaiian Islands – 27% of the total listed species, on 0.29% of the nation’s land area. This dubious distinction results from a combination of long biological isolation, producing a diverse biota of endemic species derived from relatively few original colonists, and severe ecological disturbance following the arrival of humans and introduction of alien species including ungulates, plants, and insects. Subsequent changes in the fire regime and hydrology as a result of direct and indirect human impacts have made many of these effects irreversible.

Positioned in the middle of the Pacific Ocean, Hawai‘i has also long been an important strategic location. U.S. military bases and training areas, including Kawailoa and Kahuku Training Areas, Schofield Army Barracks, Mākua Military Reservation, and Naval Magazine Lualualei, utilize about 20% of the land area of O‘ahu, and significant facilities are present on

Kaua‘i (Pacific Missile Range Facility) and Hawai‘i island (Pōhakuloa Training Area). Large parts of these sites are undeveloped, and longtime restrictions on human access have resulted in reduced impacts compared to other areas. As a result, Hawai‘i military lands contain a high number of endangered species: 12 plants and 4 animals at Pōhakuloa (Center for the Environmental Management of Military Lands 2006), and 58 plants and 13 animals on the various O‘ahu training areas (Pacific Cooperative Studies Unit 2005). With a legal mandate to protect endangered species found on military lands and mitigate any impacts caused by training, the Army has undertaken vigorous conservation programs on O‘ahu and Hawai‘i, including conducting management on nearby state forest reserve lands.

Hawaiian *Hylaeus (Nesoprosopis)*

The Hawaiian Islands are globally unique for their combination of being high islands capable of generating rainfall, and their extreme isolation from any other similar land masses. Located approximately 3700 km from the nearest continent and 3400 km from the nearest oceanic high islands, relatively few colonists have managed to survive such a long overwater dispersal and reach the islands themselves. As a result, the biota is depauperate at the higher levels of order and family – and many dominant continental groups, such as ants, social wasps, and most aquatic orders (aside from Odonata), are lacking entirely – but many of those that do survive have evolved into large radiations of diverse species (Zimmerman 1948).

While bees are highly diverse in most continental systems, they are poorly represented on oceanic islands. Only one group, the yellow-faced bees (*Hylaeus*, family Colletidae), has colonized Hawai‘i. The Hawaiian species belong to the subgenus *Nesoprosopis*, which are found primarily in East Asia (Hirashima 1977) and presumably arrived from there. At present, 63 species are known, all derived from a single ancestor (Daly and Magnacca 2003, Magnacca 2011). In keeping with the trend among Hawaiian taxa, while this number is low relative to a continental region of similar size, it represents 10% of the world’s *Hylaeus* species, and more than are found in all of North America (49). They have adapted to virtually all habitats in the islands, ranging from coastal strand to montane wet forests to subalpine shrubland above 10,000 feet, and early naturalist R.C.L. Perkins described them as “almost the most ubiquitous of any Hawaiian insects” (Perkins 1913). They are solitary and almost exclusively visit native plants, for which they are important pollinators.

However, like much of the native biota, *Hylaeus* have experienced dramatic range reductions, population declines and possibly extinctions over the last 100 years. Ten species have not been collected in at least 80 years, and another five appear to have been extirpated from one or more islands where they were historically known (Magnacca 2007a). As a result, thirty-three yellow-faced bee species were placed on the U.S. Fish and Wildlife Service Category 2 candidate list, and were later reclassified as “Species of Concern” (SOC) in 1996 (U.S. Fish and Wildlife Service 1996). In March 2009 an international invertebrate conservation organization, The Xerces Society, petitioned for the federal listing of seven species of yellow-faced bees (*Hylaeus anthracinus*, *H. assimulans*, *H. facilis*, *H. hilaris*, *H. kuakea*, *H. longiceps*, and *H. mana*), citing that there are sufficient data which show them to be at imminent risk of extinction. In June 2010, the U.S. Fish and Wildlife Service responded by publishing a 90-day finding for the seven species, and in September 2011 the agency’s 12-month finding determined that listing the species as endangered was warranted but precluded by higher-priority actions, and placed them on the candidate endangered species list.

Despite attracting interest from the beginnings of entomological studies in Hawaii, there is still relatively little known about the natural history of the native *Hylaeus*, including their precise habitat preferences, nesting habits, and patterns of floral usage. There was a gap between 1930 and 1990 during which they were virtually ignored, and most of the recent distribution data comes from surveys conducted from 1999–2002 as part of the lead author's graduate study (Daly and Magnacca 2003). The goal of this project was to expand knowledge of the distribution of rare species in preparation for management on military lands in the event that they are federally listed under the Endangered Species Act.

Geographic Setting

Below we describe the vegetative characteristics of the main target sites of this survey, with particular reference to plants favored by bees and previous collections.

Pōhakuloa Training Area and adjacent sites

Pōhakuloa is a sprawling military training site located in the broad plateau between Mauna Loa, Mauna Kea, and Hualalai (Figure 1). Since it primarily sits on Mauna Loa, the entire area of PTA consists of a mosaic of substrates of varying age and consequently differing vegetation. The flat central region is an impact area for live fire exercises and is completely off-limits; it is also only sparsely vegetated. Two sections, Area 22 (including Kīpuka Kalawamauna) in the northwest and Area 23 (Kīpuka ʻAlalā) in the southwest, receive little training activity and are intensively managed for rare plants. Area 4, in the northeast, includes a section of the old Saddle Road and is also largely unused for training; it is adjacent and similar to Mauna Kea State Park. Area 21 (Redleg Trail), in the east, includes most of the ground live-fire ranges. To the south, it adjoins the Mauna Loa Forest Reserve, and several small kīpuka ("islands" of denser vegetation surrounded by bare lava) in the vicinity of Puʻu Kōlī are vegetatively similar to those found inside Area 21.

Kīpuka Kalawamauna is largely shrubland with scattered trees, with stands of *Euphorbia (Chamaesyce) olowaluana* dense in some areas. Floral resources are dominated by *Euphorbia*, *Bidens menziesii*, *Dubautia linearis*, and *Dodonaea*, with some *Sida*. On the western side of the Kīpuka Kalawamauna fence, *Euphorbia* is regenerating strongly after suffering from intense grazing pressure; those outside the fence continue to die, especially during droughts when feral sheep and goats are driven to strip bark from the trees. Most of the remainder of Area 22 consists of open *Metrosideros* forest, with or without a shrub understory. There are some kīpuka that contain almost entirely *Myoporum*, but the entire west side of PTA has been extremely heavily impacted by the myoporum thrips (*Klambothrips myopori*). This has caused heavy mortality in combination with recent droughts and greatly reduced flowering in the survivors, and consequently it is not a major foraging source for bees there anymore (pers. obs.). Four species of *Hylaeus* were collected here in 1999: *H. difficilis*, *H. laetus*, *H. ombrias*, and *H. pele*.

Area 23 consists of mixed short-stature *Myoporum-Sophora* forest with significant stands of *Euphorbia olowaluana* and a dense shrub component including *Dodonaea* and *Bidens menziesii*. Taller trees, including *Santalum paniculatum* and *Metrosideros*, are present in the southern portion. In 1999, eight species were collected here: *H. difficilis*, *H. dimidiatus*, *H. inquilina*, *H. kona*, *H. laetus*, *H. paradoxicus*, *H. pele*, and *H. sphecodoides*, primarily on *Euphorbia*.

Area 21 is largely sparsely vegetated lava, with scattered shrubs on younger flows and a few small kīpuka of *Myoporum* or *Metrosideros* on older substrates accessible along the Redleg Trail. Along the old Hilo-Kona Road to the south are another group of *Myoporum-Sophora*

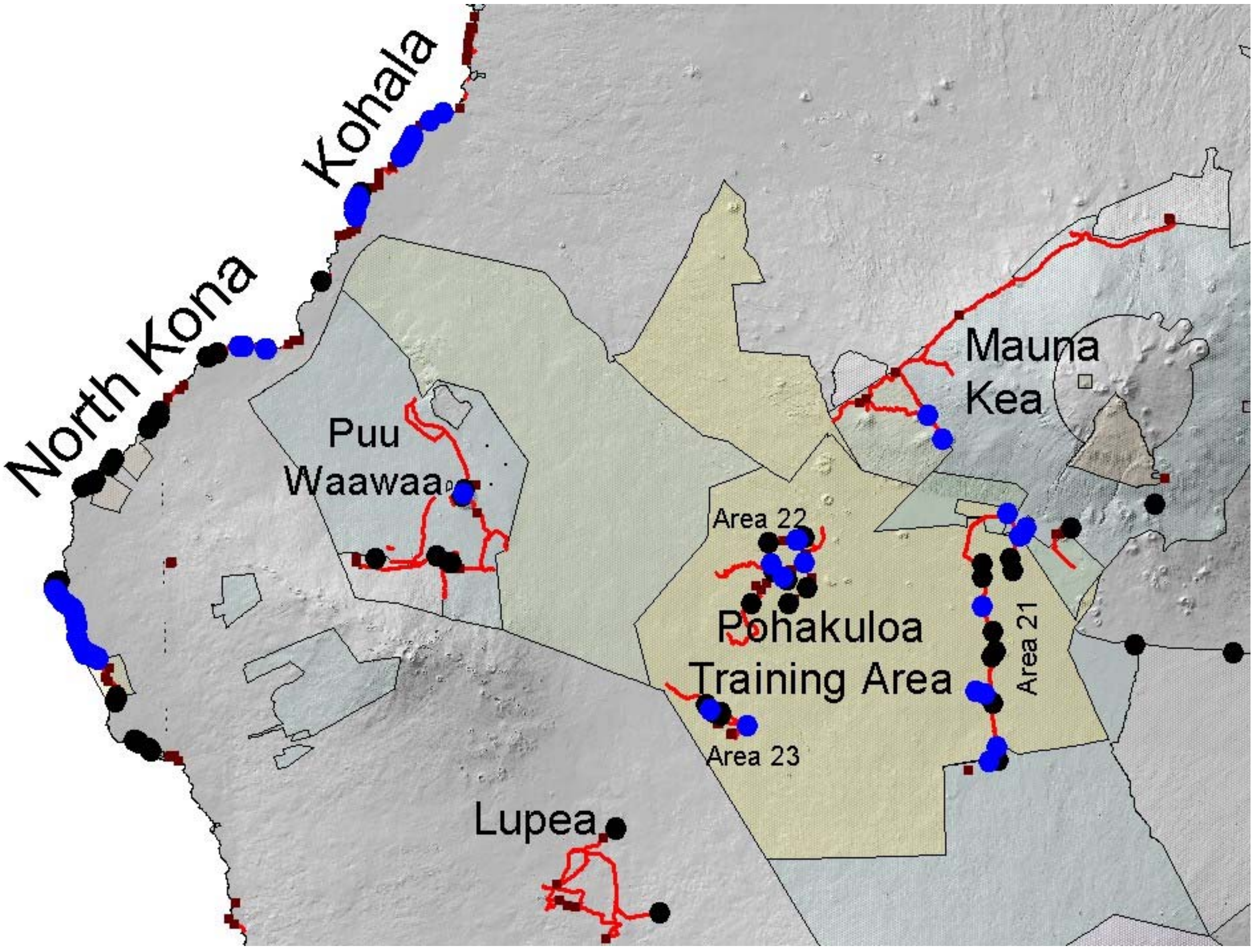

Figure 1. Northwest coast and montane areas of Hawai‘i island, showing survey sites. Red lines indicate roads and trails where surveying was conducted. Blue dots are sites where at least one target *Hylaeus* species was found, black dots are sites where other (non-target) *Hylaeus* species were found, and small brown squares are specific sites with suitable vegetation that were surveyed but where no *Hylaeus* were found, including sites where only alien bees were present.

kīpuka on state land in the Mauna Loa Forest Reserve, near Pu‘u Kōlī. To the north, Area 4 contains a patch of open *Myoporum-Sophora* forest on Mauna Kea substrate along the old Saddle Road, which is continuous with Mauna Kea State Park across the new Saddle Road alignment. The myoporum thrips is present throughout the area but currently causes much less damage than on the west side of PTA, and many *Myoporum* trees were flowering abundantly. None of these sites have been searched for *Hylaeus* previously.

Lupea

Lupea is located on the western slope of Mauna Loa in North Kona at an elevation of 1580–1800 m, at the contact boundary with Hualalai lava flows (Figure 1). It is about eight km west of Pōhakuloa, on the other side of the Mauna Loa-Hualalai saddle. The land is part of a large tract of land owned by Kamehameha Schools (Keauhou-Kona) and was formerly leased for ranching, when it was known as the Pulehua Ranch and later W.H. Greenwell Ranch. While working on the Fauna Hawaiiensis project, R.C.L. Perkins stayed at Pulehua and collected widely in the area; he reported koa finches and the Kona grosbeak to be abundant here in 1892 and 1894, but they had declined significantly by 1896 and become extinct by 1902. Perkins collected 11 species of

Hylaeus here: *H. connectens*, *H. difficilis*, *H. dimidiatus*, *H. kona*, *H. ombrias*, *H. paradoxicus*, *H. pubescens*, *H. setosifrons*, *H. simplex*, *H. sphecodoides*, and *H. volcanicus*. However, most came from 1200 m elevation or below, where the forest is now largely destroyed.

The flora consists of dry forest with a generally open tree canopy of *Santalum paniculatum*, *Myoporum*, *Sophora*, and *Acacia*, with grass below. In some areas *Santalum* is the dominant tree; some of the largest specimens in the state can be found here, as they were spared the ravages of the sandalwood harvesting during 1790–1830. A few pockets of *Metrosideros* occur, but overall this widespread tree is unusually rare here. There is little reproduction of shrubs in the understory due to the continued presence of sheep, but the area is currently in the process of being fenced off. Above this forest band, there is a large expanse of relatively intact dry shrubland on pahoehoe flows, consisting of *Dodonaea*, *Leptecophylla*, and scattered *Metrosideros* trees.

Mauna Kea

The upper area of Mauna Kea is encircled by a jeep road, which runs for most of its length between 2100–2600 m elevation (Figure 1). On the west side it begins at Ka‘ohe Game Management Area, northwest of PTA, and proceeds clockwise around the mountain for 60 km close to the lower boundary of Mauna Kea Forest Reserve, until reaching Hale Pohaku on the summit access road. Below the road on all sides the land has been ranched for over 100 years and little native vegetation remains, with the exception of the Puu Mali restoration area on the north side. The eastern slopes mostly contain shrubland and previous visits have found few bee species; it was therefore ignored during this survey. Collecting efforts focused on the remnant dry forest areas of Ka‘ohe GMA in the west and Puu Mali in the north; in between is largely shrubland. Both contain open *Myoporum-Sophora* treeland, with a grassy understory as a result of grazing by sheep (Puu Mali is now fenced). Some *Euphorbia olowaluana* and *Santalum paniculatum* are also present at both sites. *Hylaeus flavipes*, *H. laetus*, and *H. ombrias* were collected here in 1995–99.

East of Mauna Kea State Park is another section of similar forest in Mauna Kea Forest Reserve. Much of the better-quality forest that had existed at this site burned in August 2010, killing all trees in the affected area, but a small remnant persists on and above Puu Ko‘ohi. *Euphorbia* is especially abundant here. An area of high-elevation shrubland occurs at Hale Pōhaku near the treeline, dominated by *Dodonaea* and *Leptecophylla* with scattered *Sophora*, and a few outplanted *Argyroxiphium sandwicense sandwicense*.

Pu‘u Wa‘awa‘a

The ‘ahupua‘a (land section) of Pu‘u Wa‘awa‘a (Figure 1) was leased as a ranch between 1898 and 2000. During that time, the formerly rich forests became severely degraded, and now much of the lower, drier forest is either gone or is relatively undiverse, with an open to semi-closed canopy of *Metrosideros*, scattered *Myrsine lanaiensis*, and little else. A significant number of rare plants still occur, but mostly as single or widely separated individuals. The most intact and wettest forest, in the southwest portion, was set aside in 1984 as a wildlife sanctuary. Like Pōhakuloa, the vegetation may vary depending on the substrate, but since the entire area is relatively old, the history of fires and grazing has a greater impact. The best locations for bees are along the eastern and northern boundaries of the wildlife sanctuary, where the mesic forest rapidly transitions to dry forest. In the latter, *Metrosideros*, *Myoporum*, *Santalum paniculatum*, and *Sophora* occur abundantly, along with rare stands or individuals of *Euphorbia olowaluana*.

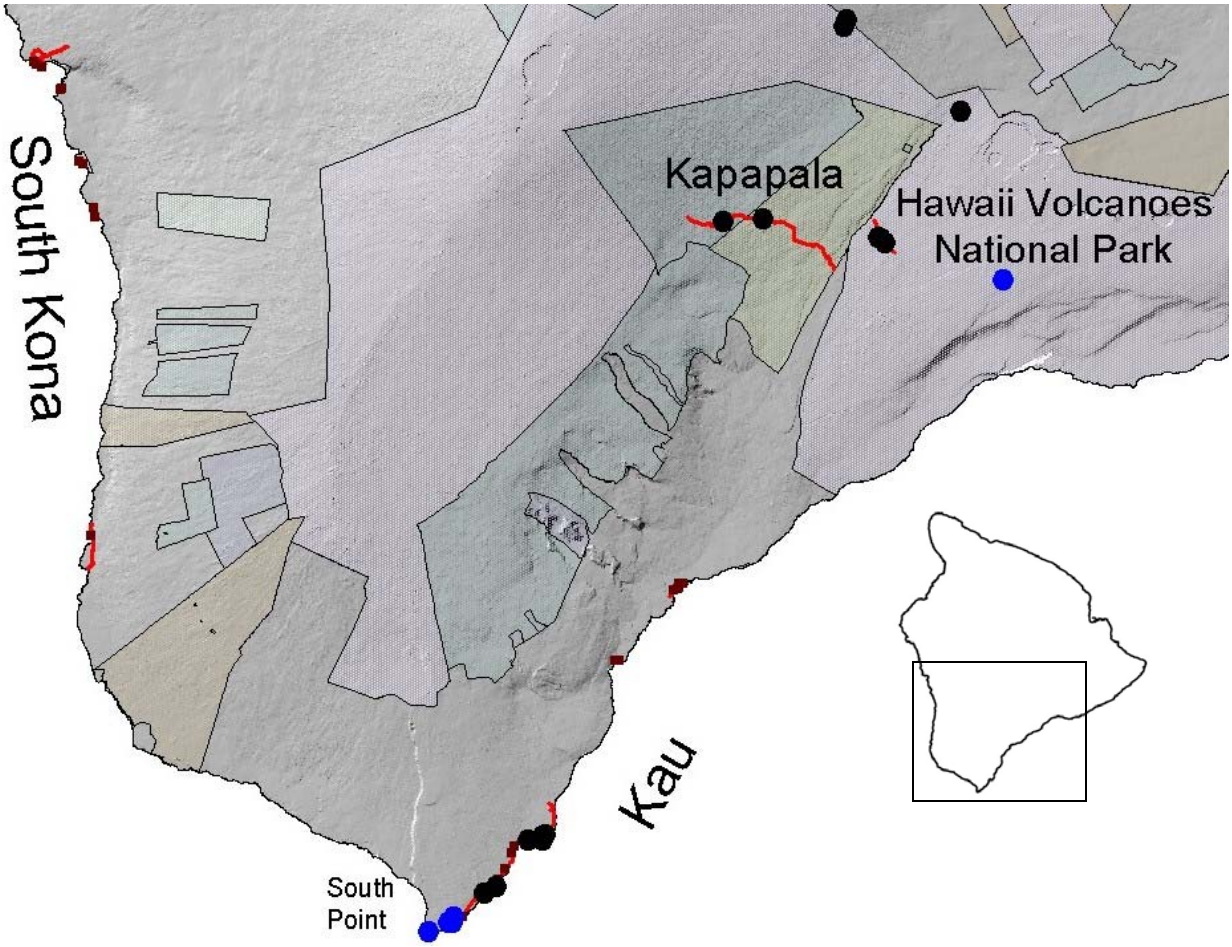

Figure 2. Southern portion of Hawai‘i island, showing survey sites. Marks as in Figure 1.

Inside the sanctuary fence, where sheep are excluded, regeneration of *Sophora* has been significant in some areas. In 2002, nine species of *Hylaeus* were collected here, all on a single *Euphorbia* tree – *H. akoko*, *H. coniceps*, *H. difficilis*, *H. dimidiatus*, *H. filicum*, *H. hula*, *H. laetus*, *H. paradoxicus*, and *H. pele*. The cinder cone for which the area is named also has a diverse flora, but naturally-occurring plants are relatively few; it is currently undergoing restoration.

Ka‘ū mauka

The mauka (upland) regions of the Ka‘ū district in the southwest of Hawai‘i includes Hawai‘i Volcanoes National Park and Kapāpala and Ka‘ū Forest Reserves (Figure 2). The last is largely wet forest and was not sampled. Northwest of Kīlauea caldera between 1200 and 2000 m elevation, the slopes of Mauna Loa are covered in a mosaic of mesic to dry forest and shrubland of varying composition. Major plants include *Acacia*, *Dodonaea*, *Leptecophylla*, *Metrosideros*, *Myoporum*, *Santalum paniculatum*, *Sophora*, and in a few places *Sapindus saponaria*. This area was severely degraded by cattle in the past, but has recovered significantly under national park management. Perkins collected most non-coastal Hawai‘i island species from various locations around Kīlauea. The area was still moderately diverse during 1999–2002 collecting, but many rarer species were lacking – only *H. coniceps*, *H. difficilis*, *H. dumetorum*, *H. hula*, *H. inquilina*, *H. laetus*, *H. pele*, *H. pubescens*, *H. setosifrons*, and *H. volcanicus* were found. Kipuka Nēnē, a diverse mid-elevation dryland site at around 900 m including *Sophora* and upland *Sesbania*, had a number of additional species: *H. connectens*, *H. difficilis*, *H. flavipes*, *H. inquilina*, *H. laetus*, *H. pele*, *H. rugulosus*, *H. sphecodoides*, and *H. volcanicus* were collected there.

Hawaiʻi leeward coast

The leeward coast of Hawaiʻi in the Kohala, Kona, and Kaʻū districts is largely devoid of intact, diverse, native coastal vegetation. The area between Kawaihae in the north and Keauhou in the south (Figure 1) is heavily developed for tourism, though the impact of development has not always been entirely negative. Coastal vegetation is dominated by indigenous *Scaevola taccada* and *Ipomoea pes-caprae*, and the introduced *Heliotropium foertherianum* (=*Tournefortia argentea*, tree heliotrope) and *Prosopis pallida* (kiawe). Several large expanses of bare lava, less than 500 years old, occur along the coast, notably at Kaʻūpūlehu ; these are almost entirely devoid of vegetation. *Hylaeus* primarily occur on intermediate-aged flows 1,500–5,000 years old, where the rock has weathered somewhat and sand accumulated close to the shore, but little soil developed. At these sites, *Heliotropium* trees may form a scattered to dense line just above the beach or rocky shoreline, while *Prosopis* and other alien plants dominate further mauka. Flows older than 5,000 years, such as from Waialea Bay northwards and along most of the coast between Kailua and Kealakekua, tend to have less *Heliotropium* and *Scaevola*, with *Prosopis* occuring down to the shore. Further south, the coast is slightly wetter and fewer host plants occur; however, there are also fewer access points, limiting the area that can be searched for bees.

This habitat is nearly contiguous from Puakō to Kailua-Kona except where it is interrupted by the 1859 and 1800–1801 lava flows. The Kailua-Keauhou area is heavily developed, and from there south to South Point is mainly younger lava flows with slightly more rainfall, often with non-native vegetation. Several sites of varying age with suitable vegetation can also be found on the Kaʻū coast, including one diverse area at Kamilo (Figure 2).

Oʻahu coast

Native coastal vegetation is extremely rare on Oʻahu (Figure 3). In contrast to Hawaiʻi, the leeward (western and southern) shores are almost completely devoid of both *Scaevola* and *Heliotropium*, with only scattered individuals occurring across most of the area. The *Scaevola-Heliotropium* vegetation type is found scattered on the windward side and north shore, but the coastal *Hylaeus* are not generally found in wetter sites such as these. The best sites are on the opposite tips of the island – in the northwest, from Mokulēʻia Beach west to Kaʻena Point, and in the southeast, from Sandy Beach east to Kaloko and at Makapuʻu Beach Park. Kaʻena Point and small areas at Kaloko and Makapuʻu contain diverse coastal vegetation including *Myoporum sandwicense*, *Santalum ellipticum*, *Sesbania*, *Sida*, and (at Kaʻena) *Euphorbia celastroides*. During 1999–2002, *H. anthracinus* and *H. longiceps* were found abundantly at Kaʻena; no bees were found at Makapuʻu and the other sites were not searched.

A small remnant of *Myoporum stellatum* shrubland occurs at Kalaeloa on the ʻEwa plain near the southwest tip of the island. The site is adjacent to Kalaeloa airport (the former Barber's Point Naval Air Station) and most of the surrounding land is or was developed for heavy industry or military use. Nearly all the remaining vegetation is non-native, and this site is the only one for *M. stellatum*.

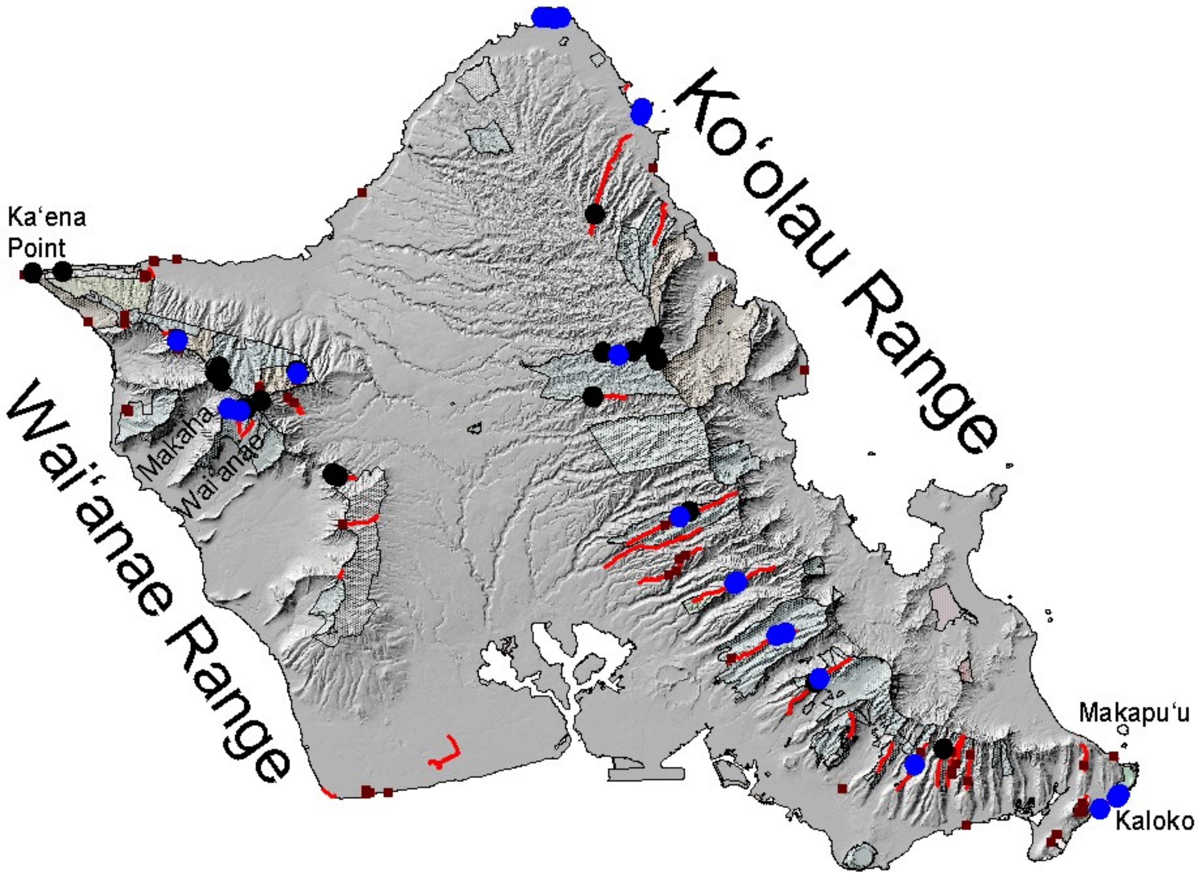

Figure 3. O‘ahu collecting sites. Marks as in Figure 1.

Ko‘olau range

The Ko‘olau range extends along the eastern half of O‘ahu, nearly perpendicular to the direction of the trade winds (Figure 3). Due to the relatively low height of the crestline, 700–850 m, there is not a strong rain shadow effect and both the windward and leeward sides of the mountains contain wet forest in the upper reaches, grading into mesic forest on lower portions of both sides. Trails extend up many of the ridges, particularly in the southern and central portions; the northern leeward section and the windward side have much more limited access due to military leases and steep terrain respectively. Most of O‘ahu was deforested by the early 1900’s as a result of grazing by goats, and what has grown up since their removal has been non-native vegetation (Liebherr and Polhemus 1997). Consequently, on most ridges native vegetation does not begin until reaching an elevation of 400–500 m. In the lower, drier zone, the main flowers visited by *Hylaeus* include *Acacia*, *Metrosideros*, *Santalum freycinetianum*, and *Scaevola gaudichaudiana*; the transition to wet forest proper typically occurs around 600 m, and *Metrosideros* and *Scaevola mollis* are the main floral resources. *Euphorbia multiformis* is sometimes present if native plants extend low enough, but bees have not been found on it here. In 1999–2002, *H. connectens*, *H. mimicus*, and *H. unicus* were collected throughout the elevational range, along with one collection of *H. mana* in the *Santalum* zone and one of *H. specularis* in the wet forest zone. Three species – *H. anomalus*, *H. facilis*, and *H. fuscipennis* – were relatively abundant throughout this area during the early collecting period of 1892–1930, but have not been seen since. This may be due to vegetation changes since that time; *H. facilis* is mainly found in dry shrubland, which has largely disappeared, and *H. fuscipennis* is associated on Maui Nui with *Cheirodendron*, which is now restricted to the crestline.

Wai'anae range

Due to its leeward position, the Wai'anae range receive much less rainfall than the Ko'olau range and contains primarily dry to mesic forest, with wet forest occurring only at the summit of Ka'ala (Figure 3). As in the Ko'olau range, alien plants dominate the lower reaches (often up to 600 m elevation or more). Despite wide differences in aspect, the ridges of this area are remarkably similar in vegetative composition (gulches, in contrast, may differ strongly from one to the next, but they are dominated by plants not attractive to bees, and many are entirely non-native). The dominant trees are *Acacia* and *Metrosideros*, with occasional *Santalum freycinetianum*, and abundant *Bidens torta*, *Dodonaea*, and usually *Euphorbia multiformis* in the shrub layer. Some of the higher summit peaks are wetter and dominated by *Metrosideros*. Ridges ascending from large valleys such as from Wai'anae or Mākaha may have more diverse vegetation than those coming directly from the plain due to greater moisture, but these are fewer and more difficult to access. Relatively little collecting was done here compared to other areas, but *H. connectens* and *H. unicus* were found at several sites in 1999–2002. In addition, several rare species are known only from sporadic records in the Wai'anae range: *H. laetus* from Pāhole in the north, *H. kuakea* from a ridge below Pu'u Hāpapa in the central part, and *H. kuakea*, *H. makaha*, and *H. ulaula* from a patch of rare *Euphorbia rockii* in Mākaha Valley.

Methods

Five of the seven candidate species – *H. anthracinus*, *H. assimulans*, *H. facilis*, *H. kuakea*, and *H. mana* – are known from military sites or immediately adjacent to them on similar habitat (Daly and Magnacca 2003, Magnacca 2007b). In addition to these, 15 rare species that may be the subject of future listing proposals were also included as targets based on their conservation status ranking (Magnacca 2007a) – *H. akoko*, *H. anomalus*, *H. dimidiatus*, *H. filicum*, *H. flavipes*, *H. fuscipennis*, *H. hula*, *H. kona*, *H. laetus*, *H. makaha*, *H. ombrias*, *H. paradoxicus*, *H. specularis*, *H. ulaula*, and *H. volatilis*. During the course of the study, it was decided to drop *H. specularis* as a target species due to the greatly increased collecting effort required for it alone with limited likelihood of success, and four additional species were included. *Hylaeus longiceps* is a candidate species that was not included in the original proposal but occurs in the same habitat as *H. assimulans* on O'ahu; *H. mimicus* was originally considered to be common enough to be of little concern, but was rarely found during the survey; *H. rugulosus* was expected to be limited to sites outside the target areas but was found at several new localities; and a new species, *Hylaeus mamo*, was discovered on O'ahu.

The habits and biology of *Hylaeus*, combined with the environment of Hawai'i, make these bees impossible to survey quantitatively using methods such as bee plots (LeBuhn et al. 2003). Experience has repeatedly demonstrated that unlike many bees, they are not attracted to bowl or pan traps (LeBuhn et al. in press), even when they can be observed flying over the ground in the immediate vicinity. Even during peak season, flowers that can be reached by a human collector are often few and widely scattered, and capture rates per bee spotted are relatively low. Frequent co-occurrence of common species with rare ones make observational counts unreliable for the purpose of documenting rare species. *Hylaeus* also only visit flowers during sunny periods, and Hawaiian weather is notorious for changing by the minute, particularly in the montane areas

Table 1. Major flowers targeted in this survey.

Species	Common Name	Family	Island
Acacia koa	koa	Fabaceae	
Argyroxiphium kauense	ʻāhinahina	Asteraceae	Hawaiʻi
Argyroxiphium sandwicense	ʻāhinahina	Asteraceae	Hawaiʻi
Bidens menziesii	koʻokoʻolau	Asteraceae	Hawaiʻi
Bidens torta	koʻokoʻolau	Asteraceae	Oʻahu
Dodonaea viscosa	ʻaʻaliʻi	Sapindaceae	
Dubautia linearis	naʻenaʻe	Asteraceae	Hawaiʻi
Euphorbia celastroides	ʻakoko	Euphorbiaceae	Oʻahu
Euphorbia multiformis	ʻakoko	Euphorbiaceae	Oʻahu
Euphorbia olowaluana	ʻakoko	Euphorbiaceae	Hawaiʻi
Euphorbia rockii	ʻakoko	Euphorbiaceae	Oʻahu
Heliotropium foertherianum	tree heliotrope	Boraginaceae	
Leptecophylla tameiameiae	pūkiawe	Epacridaceae	
Metrosideros polymorpha	ʻōhiʻa lehua	Myrtaceae	
Myoporum sandwicense	naio	Scrophulariaceae	
Sapindus oahuensis	kaulu	Sapindaceae	Oʻahu
Sapindus saponaria	manele	Sapindaceae	Hawaiʻi
Scaevola gaudichaudiana	naupaka kuahiwi	Goodeniaceae	Oʻahu
Scaevola mollis	naupaka kuahiwi	Goodeniaceae	Oʻahu
Scaevola taccada	naupaka kahakai	Goodeniaceae	
Sophora chrysophylla	mamane	Fabaceae	Hawaiʻi
Santalum ellipticum	ʻiliahialoʻe	Santalaceae	Oʻahu
Santalum freycinetianum	ʻiliahi	Santalaceae	Oʻahu
Santalum paniculatum	ʻiliahi	Santalaceae	Hawaiʻi
Sesbania tomentosa	ʻohai	Fabaceae	
Sida fallax	ʻilima	Malvaceae	

where most of the species occur. Therefore, this study is intended to look at presence or absence of bees at sites, not quantify abundance.

Sites were selected based primarily on habitat suitability. Plants with favored flowers, as determined by previous collection records and observations, are listed in Table 1. On Oʻahu, where the terrain is extremely difficult and many areas lack trails, accessibility was also a factor. On Hawaiʻi, nearly the entire North Kona-Kohala coastline between Puʻukoholā and Kailua, except for barren lava flows, was surveyed on foot along the Ala Kahakai public access trail. Each site was visited multiple times where possible, including at least once during the peak summer flowering period, in order to increase the likelihood of obtaining all potential species. Suitable flowering trees and shrubs were observed for 5–10 minutes; if no bees appeared in that time under favorable conditions, they were considered absent. Bees were netted by hand and identified back in the lab, or in the field if possible. Notes and collections were made of potential competitors and predators, namely ants and alien bees.

Results

One hundred twenty-four field survey days were conducted, 63 on Hawaiʻi and 61 on Oʻahu, spread across the various regions (Table 2). Only eleven of the 23 target species were found –

Table 2. Collecting effort across sites.

Hawai'i Region	Field Days	O'ahu Region	Field Days
coast	20	coast	11
Pōhakuloa	15	eastern Ko'olau	11
Mauna Kea	6	central Ko'olau	18
Puu Wa'awa'a	10	northern Wai'anae	10
Lupea	5	southern Wai'anae	3
Ka'ū mauka	3	leeward Wai'anae	8
other	4		

four Hawai'i species, *H. flavipes*, *H. kona*, *H. ombrias*, and *H. rugulosus*; five O'ahu endemics, *H. anomalus*, *H. makaha*, *H. mamo*, *H. mimicus*, and *H. mana*; and two from both islands, *H. anthracinus* and *H. laetus* (Table 3). One new species was discovered on O'ahu, and the record of *H. anomalus* was the first in over 40 years. The overall decline in abundance and diversity was striking compared to previous years, as even most species earlier considered relatively common were rare. In montane areas, only *H. difficilis* was found at most sites on Hawai'i and *H. unicus* on O'ahu, where previously there had been much more diversity (Daly and Magnacca 2003). Species accounts follow below.

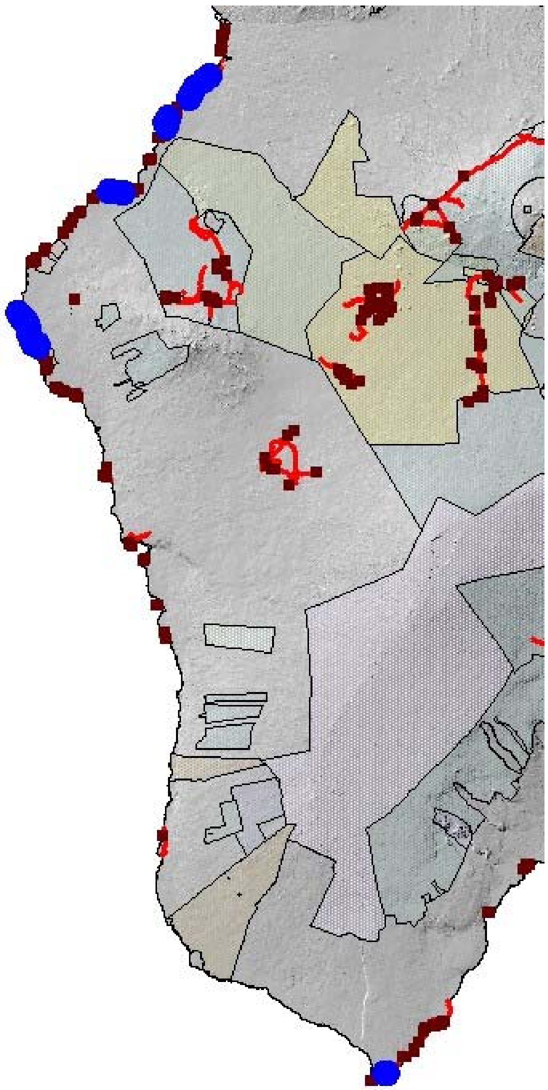

Figure 4. Distribution of *Hylaeus anthracinus* on Hawai'i (blue).

Hylaeus anomalus

This remarkable species was relatively common in early collections from the eastern Ko'olau range, through about 1930 (Daly and Magnacca 2003). Two specimens recently discovered in the University of Hawai'i–Mānoa Insect Museum, one from Tantalus in 1977 and one from 'Aiea in 1978, are the only known collections since then. On the last O'ahu field day of this survey, one male and one female were collected around flowers of *Acacia koa* on Kamaileunu ridge, between Mākaha and Wai'anae valleys (Figure 5). This is the first record of the species from the Wai'anae range, and an indicator of how long these species can persist without being detected. Virtually no koa flowering was observed all year on either O'ahu or Hawai'i until this last visit, which may perhaps explain why certain species were in low abundance. Most available collections of *H. anomalus* appear to be from October to February, suggesting that the lack of recent collections may also be related to timing of effort (most collecting has been done in the summer, when other species are more abundant) in addition to their inherent rarity.

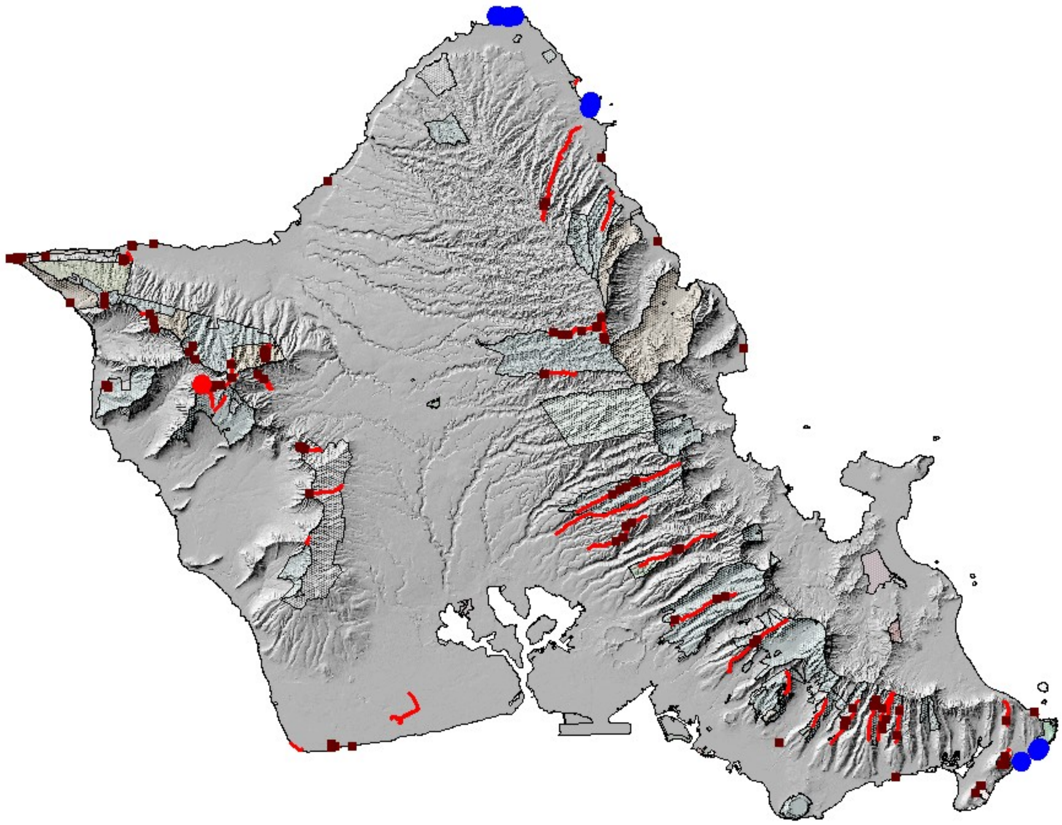

Figure 5. Distribution of *Hylaeus anomalus* (red) and *H. anthracinus* (blue) on O‘ahu.

Hylaeus anthracinus

This was the only target species to be found in significant numbers. On Hawai‘i, *H. anthracinus* occurs along several stretches of coastline in the North Kona–Kohala area: in Puakō, from Puakō village to the southern end of the Fairmont Orchid hotel property; in Waikōloa, along the frontage of the Hilton Waikoloa Hotel and Kolea condominium property; in Kīholo, at Luahinewai and Manō Point; and the largest, from Keāhole Point to Kōhanaiki, where it co-occurs with *H. difficilis* (Figure 4). Remarkably, this includes two of the large resorts that have been built in this region, indicating that they can survive contact with development. Throughout the inhabited area, they can often be found in extremely high densities, with 20–50 or more bees flying around a single *Heliotropium* tree at any given time – much more than even the most abundant of the "common" montane species.

These sites have several characteristics in common. All are rocky shoreline with *Scaevola* and *Heliotropium*, with either landscaped vegetation, alien kiawe (*Prosopis pallida*), or bare rock inland. The bees are restricted to an extremely narrow corridor between these and the ocean, typically 10–20 m wide, and do not occur on sandy beaches or inland, even on landscaped native plants on hotel grounds. Alien bees, such as *Ceratina arizonensis* and *C. smaragdula*, were sometimes found on cultivated flowers. *Hylaeus* were observed entering holes in coral rubble deposited on shore, and this may be their primary nesting site and a limiting factor on their distribution (*H. difficilis* also occurs in this area, including at sandy beach areas north of Keāhole Point and at Kekaha Kai State Park where *H. anthracinus* was not found). The widespread ant

Table 3. Target species, habitats, and summary of survey results. SOC – Species of Concern; C – Candidate endangered species.

Species	Island	Habitat	Status	Collected?	Sites
Hylaeus akoko	Hawaiʻi	dry forest			
Hylaeus anomalus	Oʻahu	mesic forest	SOC	●	Waiʻanae
Hylaeus anthracinus	Hawaiʻi, Oʻahu	coast	C	●	Kona-Kohala coast, South Point, Kahuku, Malaekahana, Kaiwi
Hylaeus assimulans	Oʻahu	coast, dry forest	C		
Hylaeus dimidiatus	Hawaiʻi	dry forest	SOC		
Hylaeus facilis	Oʻahu	dry shrubland	C		
Hylaeus filicum	Hawaiʻi	wet & mesic forest	SOC		
Hylaeus flavipes	Hawaiʻi	coast, dry forest	SOC	●	Mauna Kea, PTA, South Point
Hylaeus fuscipennis	Oʻahu	wet & mesic forest	SOC		
Hylaeus hula	Hawaiʻi	dry & mesic forest	SOC		
Hylaeus kona	Hawaiʻi	dry forest	SOC	●	Mauna Kea, PTA
Hylaeus kuakea	Oʻahu	mesic forest	C		
Hylaeus laetus	Hawaiʻi, Oʻahu	dry shrubland	SOC	●	Pāhole, PTA
Hylaeus longiceps	Oʻahu	coast	C	●	Kaʻena, Kahuku
Hylaeus makaha	Oʻahu	mesic forest		●	Manuwai, Waiʻanae
Hylaeus mamo	Oʻahu	mesic forest		●	Tripler
Hylaeus mana	Oʻahu	mesic forest	C	●	ʻAiea, Mānana, Tripler, Lanipō
Hylaeus mimicus	Oʻahu	wet & mesic forest		●	Poamoho, Lanihuli
Hylaeus ombrias	Hawaiʻi	coast, dry forest	SOC	●	Puʻu Waʻawaʻa
Hylaeus paradoxicus	Hawaiʻi	dry & mesic forest			
Hylaeus rugulosus	Hawaiʻi	dry & mesic forest		●	PTA, Saddle Road
Hylaeus ulaula	Oʻahu	mesic forest			
Hylaeus volatilis	Oʻahu	dry forest & shrubland	SOC		

Anoplolepis gracilipes (long-legged ant or yellow crazy ant) was often found in close proximity, but almost never on plants visited by *Hylaeus*; the ants were often extremely abundant in the slightly denser, moister vegetation just inland of the coastal strand, where bees were not found. The southern end of the *H. anthracinus* population is precisely at the boundary between Kōhanaiki and Kaloko–Honokōhau National Historical Park, at a point where the vegetation becomes denser and *Anoplolepis* ants become evident down to the shoreline, suggesting that they constrain the distribution of *Hylaeus*.

Just to the south, a few more sites appear suitable but had only *H. difficilis*. Beyond Kailua-Kona, there are few sites with good vegetation, and no *Hylaeus*. A very small population of *H. anthracinus* persists at Kaulana Bay just east of South Point, widely disjunct from the remainder in North Kona. However, previous work has shown that the populations are not genetically distinct, despite a high level of difference among the Kaulana individuals (Magnacca and Brown 2010), indicating that *H. anthracinus* probably formerly occurred along the entire Kona coast.

On Oʻahu, the situation is more grim. The major population on the island was at Kaʻena Point on the northwestern tip of the island, where both *H. anthracinus* and *H. longiceps* were abundant (Hopper 2002, Daly and Magnacca 2003). Repeated visits during this project found no *H. anthracinus* and only two (male) *H. longiceps*, though anecdotal reports indicate that *Hylaeus* were easily found there at least through 2010, and *Ceratina* are abundant (S. Plentovich, pers. comm.). However, two previously unknown populations were discovered on the opposite ends of the island: one in the southeast at Sandy Beach Park and Kaloko (Kaiwi Scenic Shoreline), and one in the northeast at Kahuku Point. At the former, the density of bees is high but they occur only in two extremely small patches, about 1.2 km apart (Figure 5). The larger, eastern site has an accumulation of coral rubble on the shore, and the western one is centered on a small rock wall which bees constantly flew around and entered; no such material is found where the bees are absent, though plants are still present. This strongly suggests that nest-site limitation is an important factor in the distribution of *H. anthracinus*. At Kahuku, the density is low but they occur scattered along a roughly 1 km stretch of beach. Another, smaller population was found nearby at Malaekahana, on the shore directly opposite the islet of Mokuauia. Some of the offshore islets may also have populations of *H. anthracinus*; they were documented from at least two, Mokuauia and Moku Iki, as of 2004 (Plentovich 2010). However, Mokuauia was invaded by *Anoplolepis gracilipes* ants in 2006 (Plentovich et al. 2011). The islets were not visited for this study.

The newly-arrived alien *Hylaeus strenuus* was found in company with *H. anthracinus* at Malaekahana, and not far away from the populations at Kaloko and Ka‘ena. It is potentially a serious competitor for floral resources, and regularly visits both *Scaevola taccada* and *Heliotropium foertherianum*, the two main food plants of *H. anthracinus*.

Hylaeus flavipes

This species was previously known from several widely scattered localities on Hawai‘i: Kīpuka Nēnē and South Point in Ka‘ū, and Ka‘ohe GMA and Hale Pōhaku on Mauna Kea. In this survey, *H. flavipes* was found at all of these except the last, and in addition was found in Pōhakuloa Training Area at Area 21 and Area 4, and nearby at Mauna Kea State Park (Figure 6). At all the Mauna Kea/PTA sites, it was associated with *Myoporum*. Previously, it was collected at *Sophora* at Kīpuka Nēnē and Hale Pōhaku (Daly and Magnacca 2003), but *Sophora* flowering during the survey period at these areas was brief and occurred in the fall. At Pōhakuloa, *H. flavipes* was found only at a few sites, and in July but not August. However, to the west at Ka‘ohe on Mauna Kea they were absent in July after having been found there in May, indicating that they may only be active for short periods but that their seasons differ at different sites.

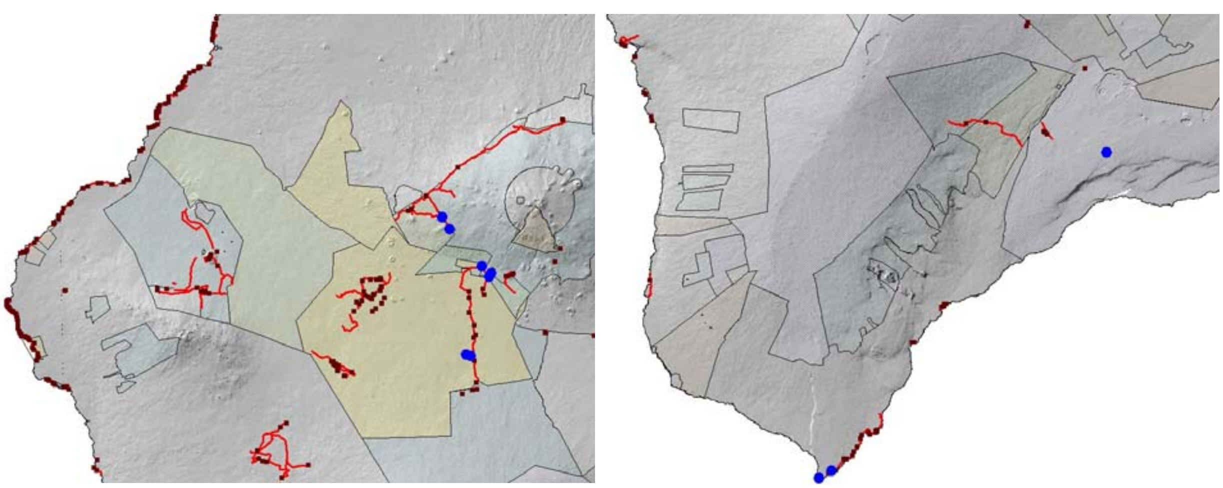

Figure 6. Distribution of *Hylaeus flavipes* in Mauna Kea and Pōhakuloa (left) and Ka‘ū (right), indicated by blue marks.

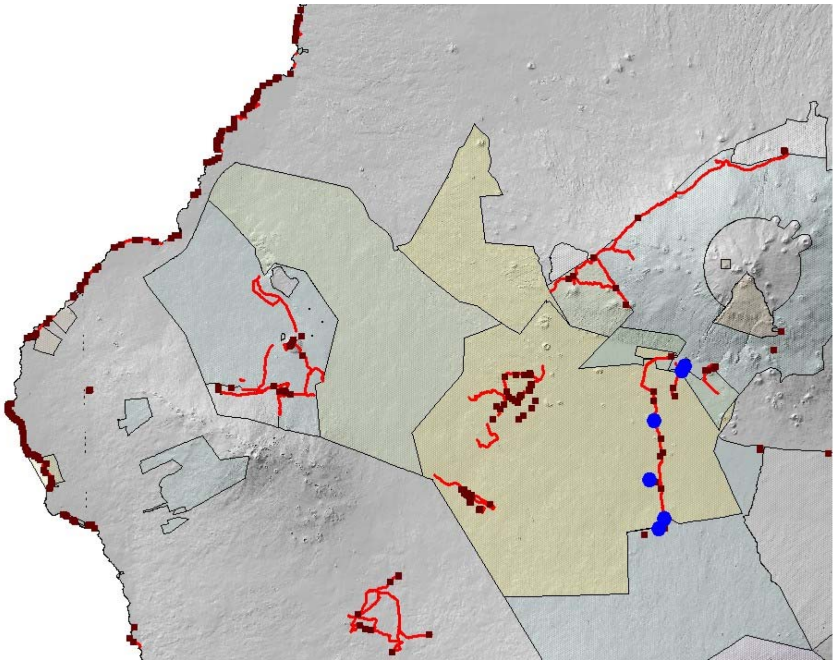

Figure 7. Distribution of *Hylaeus kona* (blue marks).

The population at South Point is extremely tenuous. The bees occur only at a small patch of windswept prostrate vegetation near the point itself, and at one *Heliotropium* patch about 2 km to the east. The area has been hit hard by the ongoing drought and by human impacts, including off-road driving and trampling, and few foraging plants were available. Most of those that were present during the first visit in March were dead or dormant by July. Likewise at Kīpuka Nēnē, the sprawling *Sesbania* runners that had served as the primary flower source for *H. flavipes* there have died back significantly compared to previous years. While *H. flavipes* was still present, the other bee species that were formerly found there in relative abundance were all missing.

Hylaeus kona

This species was found almost exclusively in July, at several sites along the Redleg Trail (Area 21) and Area 4 in Pōhakuloa Training Area, and immediately adjacent at Mauna Kea State Park and Pu‘u Kōlī (Figure 7). It was often found in company with *H. flavipes*, which it closely resembles. Followup searches from August onward failed to find either species at any of the previous sites, with the exception of a single *H. kona* found at Pu‘u Kōlī in October; only *H. difficilis*, the most common Hawai‘i species, was present at most sites. Previously *H. kona* had been found at both Kīpuka Kalawamauna (Area 22) and Kīpuka ‘Alalā (Area 23); it has not been collected elsewhere for several decades.

Hylaeus laetus

Hylaeus laetus is morphologically similar to the common *H. difficilis*, but favors middle to lower elevation dry forest and shrubland, avoiding wet forest and coastal habitats altogether. It was not originally considered a target species on Hawai‘i, since it had previously been quite common, but it was extremely rare throughout the survey (Figure 8). On Hawai‘i it was found only on the west side of PTA, and only after August. On O‘ahu it has always been rare,

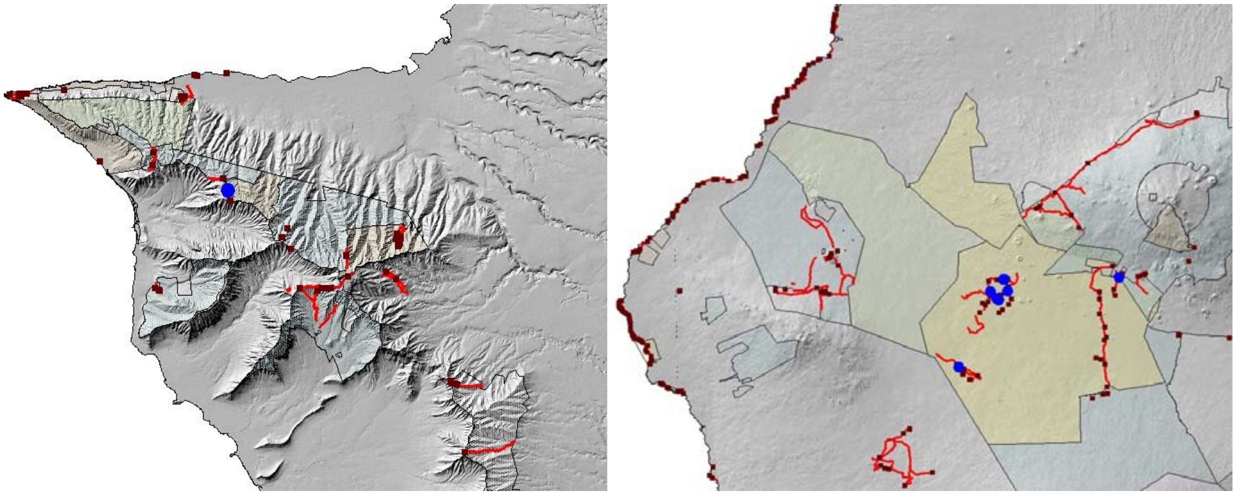

Figure 8. Distribution of *Hylaeus laetus* (blue marks) on O‘ahu (left) and Hawai‘i (right).

presumably due to the much smaller quantity of habitat available. However, it was still only collected from Pāhole, just 700 m from the sole previous collection in 2001. This was despite the expansion of collecting effort with this survey into much more dry forest and shrubland habitat, identical to that of the collection site, throughout both the northern and southern portions of the Wai‘anae range.

Hylaeus longiceps

Found on both O‘ahu and the islands of Maui Nui, this species is extremely rare on Maui but was found in moderate numbers on Lāna‘i and Moloka‘i during 1999–2002, and formerly had a significant population at Ka‘ena Point (Daly and Magnacca 2003). However, like *H. anthracinus* there, it has almost completely disappeared in the last few years. Over the course of multiple visits to Ka‘ena, only two individuals were observed (both males), despite good flowering of the plants, favorable weather, and few alien bees. This had been the only known population on O‘ahu, but late in this survey a second one was discovered at Kahuku Point (Figure 9). Although small in area, they occur at relatively high density on *Sesbania* and *Heliotropium* there. This area is potentially threatened by development – it is directly makai of the Turtle Bay Resort golf course, and although earmarked as “park” land in the Turtle Bay expansion draft supplemental EIS (Sichter 2012), impacts on native invertebrates were not considered, nor were the *Sesbania* noted in botanical surveys for the DSEIS.

Hylaeus makaha

This O‘ahu endemic species, related to *H. kona*, was only described in 2011 (Magnacca 2011). The first collection was of a single female from Mākaha Valley on the leeward side of the Wai‘anae range in September 2009, and in August 2010 more were found at the same site, along with another new species, *H. ulaula*, and the candidate species *H. kuakea* (itself only discovered in 1997 and described in 2003). Visits to the site during this survey found most of the mature individuals of the endangered plant they were primarily collected on, *Euphorbia rockii*, dead (presumably from drought stress) and no bees at all. However, a single individual was collected in the eastern Ka‘ala Natural Area Reserve while sweeping vegetation during poor weather, the first male ever found. A second collection was made in Wai‘anae Valley, on

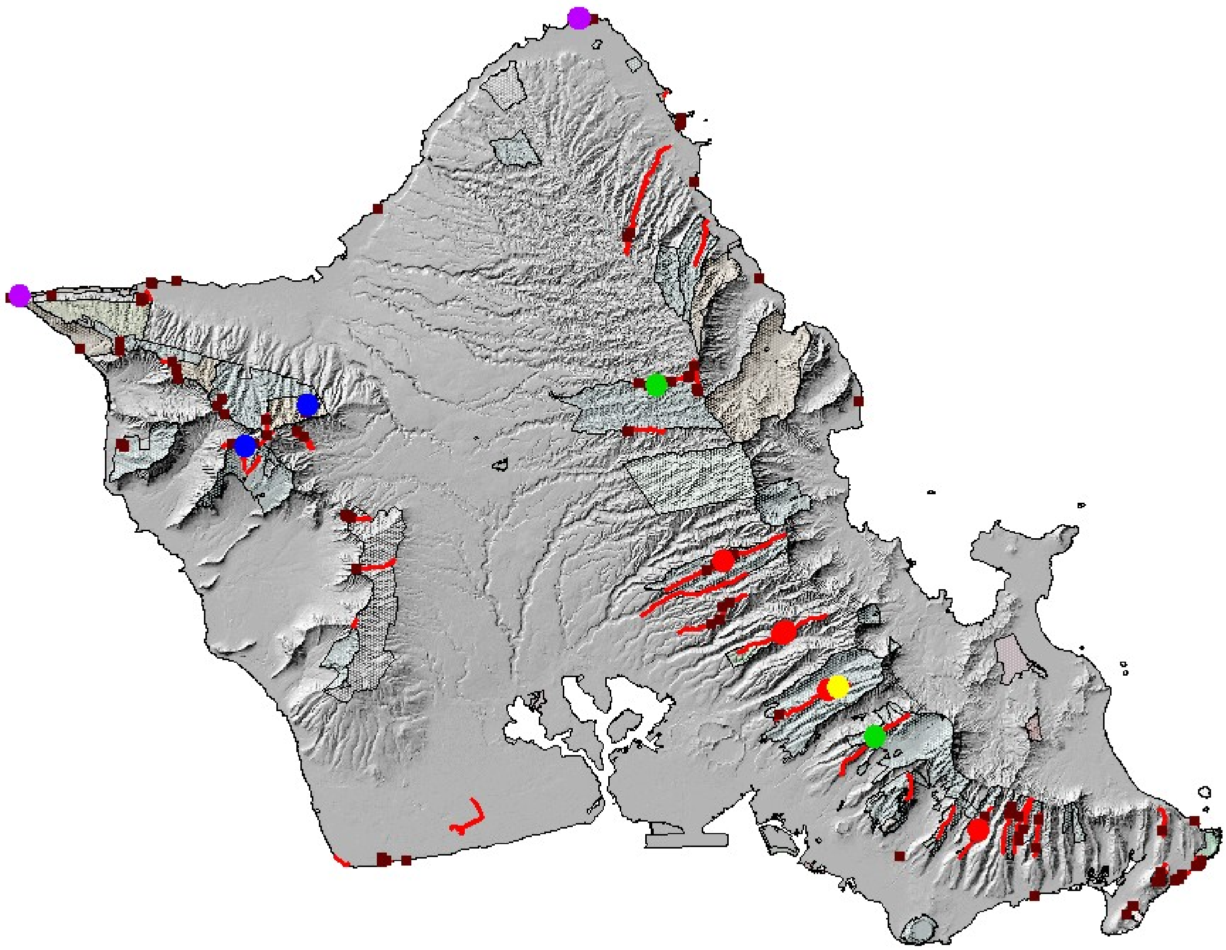

Figure 9. Distribution of *Hylaeus longiceps* (purple), *H. makaha* (blue), *H. mamo* (yellow), *H. mana* (red), and *H. mimicus* (green) on O‘ahu.

Euphorbia multiformis about 1.2 km from the original Mākaha site, with both males and females together (Figure 9). While *Euphorbia olowaluana* has been a productive species for bee collecting on Hawai‘i, the smaller species on O‘ahu have rarely been found with bees.

Hylaeus mamo

While searching for *H. mana* on Tripler ridge in the central Ko‘olau range during the last O‘ahu field trip of the survey, a single male was collected which turned out to be yet another new O‘ahu endemic species (Figure 9). It is instantly recognizable, as the only Hawaiian species with a yellow mark on the gena and the only one besides *H. kona* to have the mandibles yellow. It is quite small, like *H. mana*, and given that it has eluded detection for so long, it is probably similarly rare.

Hylaeus mana

Another rare and recently-discovered O‘ahu endemic, this species had been known only from 4 specimens collected in 2002 on the Mānana Trail at flowers of *Santalum freycinetianum*. During this survey, it was found at four ridges across the central and eastern Ko‘olau range (Figure 9). All were from the middle or lower portions of the ridge, and of the five collections three were from *Santalum* (one was of a resting bee on a cool day in the vicinity of flowering *Santalum*, and the last on *Psychotria*; the latter is probably an incidental record, since *Hylaeus* visit *Psychotria* relatively infrequently). Taken together, these records suggest that *H. mana* is a specialist on *Santalum* and is probably restricted to the relatively narrow zone where it occurs in the Koʻolau range. While *Santalum* occurs in moderate abundance and *H. mana* is probably more common than previously recognized, the narrowness of its habitat and the presence of abundant *Lasioglossum impavidum* around *Santalum* at some of the sites show that it remains under threat.

Hylaeus mimicus

Like the preceding two species, this is an Oʻahu endemic that appears to be confined to the Koʻolau range. In 1999–2002 it was collected from ʻAiea and Wiliwilinui ridges on multiple occasions and from a variety of flowers (Daly and Magnacca 2003). During this survey, only two individuals were found, one each on Poamoho and Lanihuli ridges (Figure 9). One of the plants it was collected on previously, *Scaevola gaudichaudiana*, was flowering abundantly through most of the year but had few visitors; however, there was almost no flowering of *Acacia koa*, another tree that several *H. mimicus* were collected from previously. While not a commonly-used flower in general by *Hylaeus*, if *H. mimicus* is linked to koa then it may explain the reduction in numbers of this species.

Hylaeus ombrias

Like *H. flavipes*, this is a basically coastal/lowland species that also occurs in high elevation montane dry forest habitats on Hawaiʻi. Its large size may be an adaptation to feeding on the large pollen grains of *Sida fallax* and other Malvaceae, which are visited by other *Hylaeus* but rarely utilized for pollen (Magnacca, unpublished data). During this survey, only a single individual was found, in a rare plant restoration area on Puʻu Waʻawaʻa cone (Figure 10). It was not found at South Point or PTA, where it had been found in moderate numbers previously (Daly and Magnacca 2003), despite abundant flowering of *Sida* and *Bidens* at the latter.

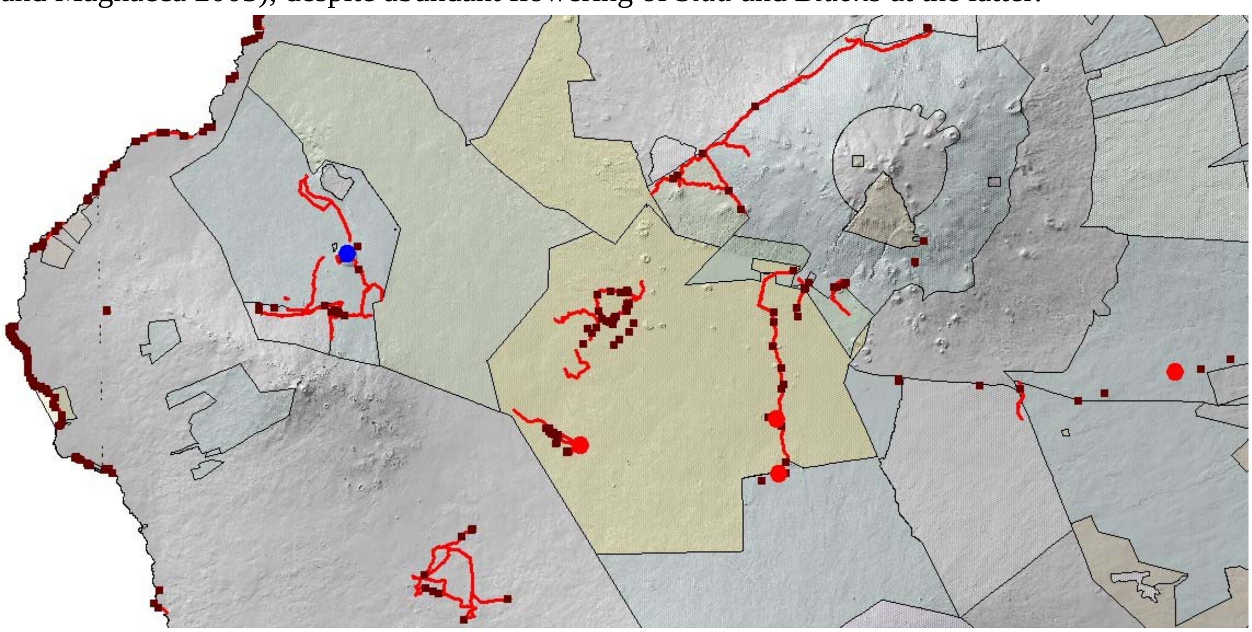

Figure 10. Distribution of *Hylaeus ombrias* (blue) and *H. rugulosus* (red) on central Hawaiʻi.

Hylaeus rugulosus

This enigmatic species appears to have no close relatives and had been known from only two recent collections, both in Hawai‘i Volcanoes National Park (Daly and Magnacca 2003). Consequently, although it was known to be rare it was not considered a target species since it was thought to occur only outside the primary survey area. However, during the course of this project it was found across a broad area of the north slope of Mauna Loa in the saddle with Mauna Kea (Figure 10). Collections came from *Metrosideros polymorpha*, *Myoporum sandwicense*, and *Dodonaea viscosa*. Although still uncommon, it was the only species other than the common *H. difficilis* to be found widely in time as well, being found in April, July, and November.

alien *Hylaeus*

At least two non-native species of *Hylaeus* are known to be established in Hawai‘i. *Hylaeus (Gnathoprosopis) albonitens*, a native of Australia, has been present since at least 1995 and is established on at least Kaua‘i, O‘ahu, Moloka‘i, and Hawai‘i (Snelling 2003). However, it appears to have remained confined to relatively few widely separated but small localities. In this survey, it was collected on Hawai‘i at lower Pu‘u Wa‘awa‘a; PTA Area 22 outside Kīpuka Kalawamauna; Palamanui, a remnant dry forest above the Kona airport; and a single individual at Waikōloa near the *H. anthracinus* population. On O‘ahu it was found only twice, at the head of Kaluakauila Valley and on the road to the summit of Mt. Ka‘ala. All of these except Waikōloa are sites with only *Metrosideros* available as a pollen source and no native *Hylaeus*.

In 2007, a new immigrant *Hylaeus* was reported from O‘ahu, and later identified as *Hylaeus (Indialaeus) strenuus* (Dathe 2011, Magnacca et al. 2011). The initial collections were strictly from coastal sites in the east Honolulu area, primarily on *Scaevola taccada*, and it was expected to be a potential serious competitor to the native coastal *Hylaeus*. Since then, it has spread throughout the island. At present, its habitat preferences are difficult to discern (all *Indialaeus* species are virtually unknown in their native range). In this survey, it was found at the coast broadly along Mokulē‘ia beach, east of Ka‘ena, and at Sandy Beach and Kaloko, near the *H. anthracinus* populations. Two collections were made on *Metrosideros polymorpha* flowers on adjacent ridges in the central Ko‘olau range, indicating the potential to invade montane habitats.

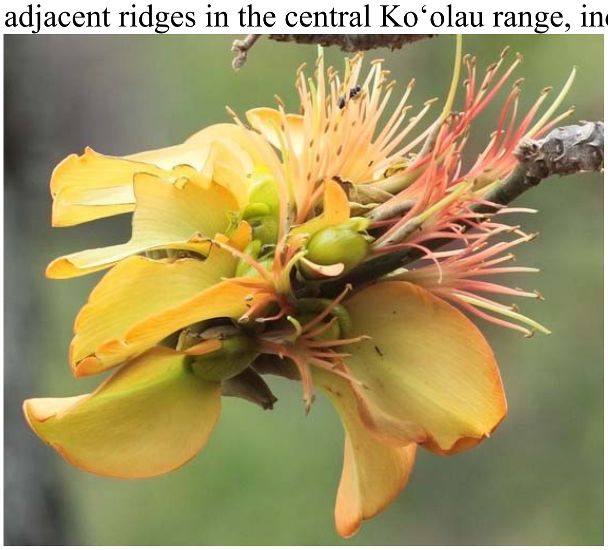

Figure 11. *Hylaeus strenuus*, a recent introduction from India. Left: female collecting pollen from the stamens of *Erythrina sandwicensis* (Fabaceae). Right: male holding a droplet of regurgitated nectar.

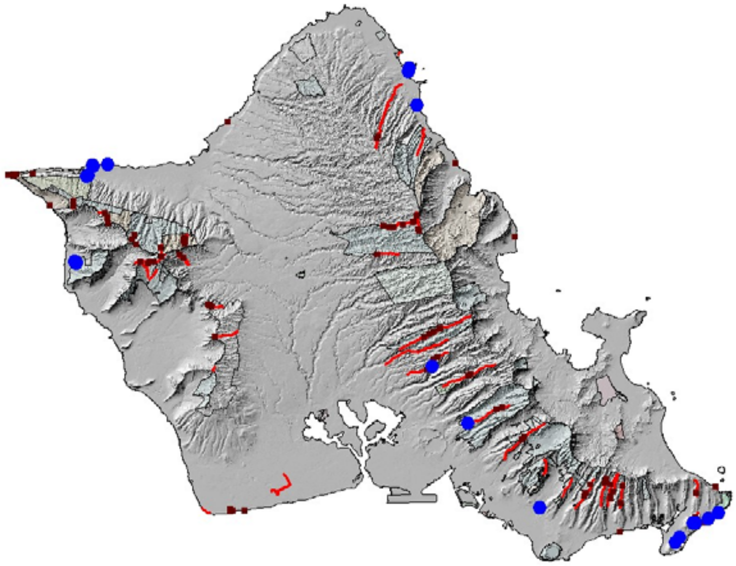

Figure 12. Distribution of *Hylaeus strenuus* (blue) on O‘ahu.

However, it was not recovered from some of the earlier sites where it was found, including Ala Moana Beach Park, suggesting it may not be competitive in these habitats. At the same time, it was consistently found at *Erythrina* flowers, both the native *E. sandwicensis* (wiliwili) and various introduced ornamental or cultivated species. These flowers are clearly evolved to be bird-pollinated – they are large, predominantly red to orange, with a large quantity of relatively dilute nectar concealed beneath overlapping petals – and no bees or other insects were seen visiting them, though honeybees are known to do so occasionally. Individuals of *H. strenuus* were repeatedly observed both climbing the long stamens to collect pollen, and extruding a droplet of nectar while resting on a branch in order to concentrate it (Figure 11). Members of the subgenus *Indialaeus* are distinctive for their broad, flat mandibles, which may be adapted for the purpose of holding these droplets. The ability of these bees to find remote *Erythrina* populations, the behavioral and morphological characters they exhibit, and their relatively limited distribution in native *Hylaeus* habitat after at least five years suggests that *H. strenuus* may not be a serious competitor to the native species, but it should be monitored.

In addition to the two species discussed above, the European *H. (H.) leptocephalus* was documented from O‘ahu in the 1950’s, but there is only a single specimen recorded since then (in 1994) and it is unknown if it is still present. While this survey was in progress, surveys in lowland disturbed sites by Dr. S. Droege (USGS) discovered a single female of a new adventive species, identified by Dr. H. H. Dathe as *H. (Prosopisteron)* sp. from Australia (Magnacca et al., submitted). Whether this species is established is unknown; searches for it in the vicinity of the original collecting site (in Kalihi Kai near the cargo docks) and elsewhere have failed to turn up additional specimens.

Ceratina

Three species of *Ceratina*, all introduced, occur in the Hawaiian Islands: *C. (Ceratina) arizonensis*, *C. (Neoceratina)* cf. *dentipes*, and *C. (Pithitis) smaragdula*. All are only found at the coast, except *C.* cf. *dentipes* which is occasionally found inland. The latter is a parthenogenic species whose exact provenance and identity are unknown (Snelling 2003). *Ceratina arizonensis* is restricted to the North Kona coast of Hawai‘i, where it co-occurs with the other two species (though it is rare for more than two of the three to occur in a single site). *Ceratina* cf. *dentipes* occurs on all the main islands, and in this survey was also found along the Ka‘ū coast and at Ka‘ena Point. Both of these species were relatively uncommon, and are probably not major competitors with *Hylaeus* despite often inhabiting the same localities.

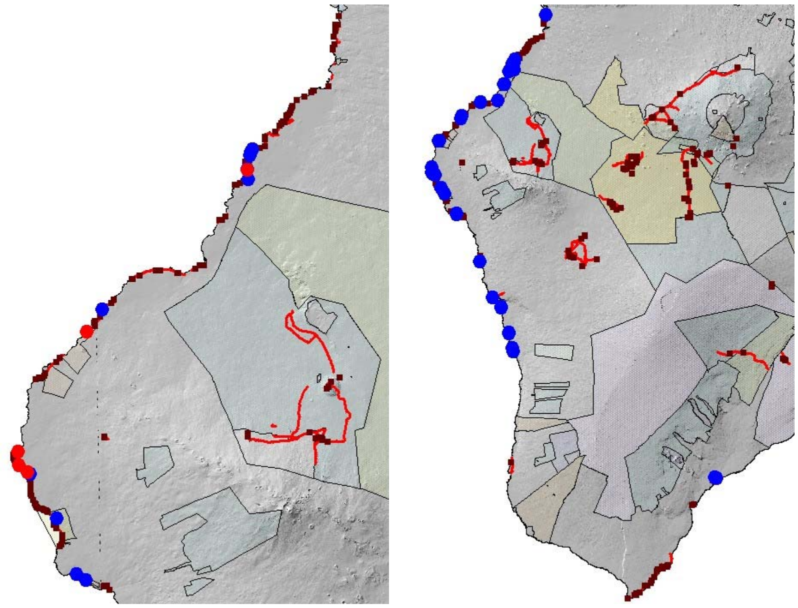

Figure 13. Left: Distribution of *Ceratina arizonensis* (red) and *C.* cf. *dentipes* (blue) in Kona, Hawai‘i. Right: *Ceratina smaragdula* on Hawai‘i (blue).

Ceratina smaragdula is the latest arrival, first recorded in 1999, but is already more widespread and abundant than the others (Figure 13). It frequently occurs in large numbers, and may be a factor in the reduction of native *Hylaeus* populations in some areas. On O‘ahu, it is found at dry coastal sites at the corners of the island: Ka‘ena, Mokulē‘ia, Kahuku, Sandy Beach, and Kalaeloa (Barber’s Point), as well as in disturbed sites. On Hawai‘i, it is found along most of the Kona-Kohala coast and at Punalu‘u in Ka‘ū, though it is notably absent from both the Puakō and Kōhanaiki-‘O‘oma areas, where the largest concentrations of *H. anthracinus* occur. The two species are sympatric at Waikōloa and Keāhole, raising the question of whether *C. smaragdula* is increasing competitive pressure on *H. anthracinus* or if in fact the latter is able to exclude the former under favorable conditions.

Lasioglossum

Only one species of Halictidae had been recorded from Hawai‘i, *Lasioglossum impavidum* (Snelling 2003). During the course of this project, collections by Dr. Sam Droege (USGS Patuxent Wildlife Research Center) found two species of *Lasioglossum (Dialictus)* widespread in

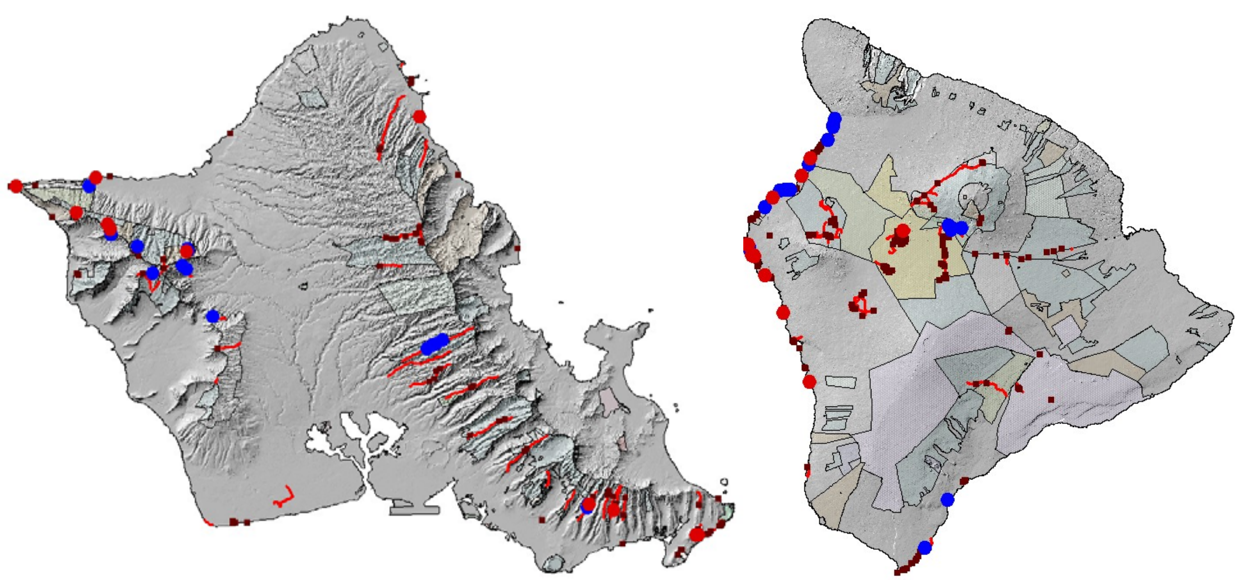

Figure 14. Distribution of *Lasioglossum impavidum* (blue) and *L. imbrex* (red) on O‘ahu and Hawai‘i.

disturbed coastal and lowland sites on O‘ahu (Magnacca et al., submitted). These were identified by Dr. Jason Gibbs as *L. microlepoides* and *L. imbrex*. On O‘ahu, these two species co-occur frequently. The former is almost entirely restricted to coastal and urban areas and is the more abundant in those habitats; so far only one collection has been made in the mountains, at Kaluakauila, in company with both other *Lasioglossum*. It has not been detected on other islands to date and is likely a recent introduction. Given its rapid dominance in disturbed habitats, it may be a significant pollinator of invasive weeds. *Lasioglossum imbrex* is also primarily found in coastal sites, but was also found on several ridges in the northern Wai‘anae range. *Lasioglossum impavidum*, the longest-established species, is almost exclusively found in the mountains on O‘ahu, but is widespread along the coast of Hawai‘i, suggesting it may have been displaced on O‘ahu by the arrival of *L. microlepoides*. Interestingly, *L. impavidum* and *L. imbrex* seem to occur interdigitated in North Kona but are only rarely sympatric (Figure 14). Both are infrequent in upper montane regions of Hawai‘i and were found there only at Pōhakuloa.

Megachile

Leafcutter bees were uncommon at most sites. *Megachile umbripennis* was widespread and found at numerous locations on the Kona coast from Honokōhau south, and a few in Ka‘ū, but did not overlap with the range of *H. anthracinus*. *Megachile timberlakei* was scattered in a few sites along the Kona and Ka‘ū coasts, co-occurring with both *H. anthracinus* and *H. flavipes* at South Point, but was rare and probably not a major competitor. It was also found on O‘ahu at Ka‘ena and Makapu‘u. A third species, *M. gentilis*, was collected on O‘ahu at Koko Head Botanical Garden. Four other megachilids are recorded from the state (Snelling 2003) but were not found here.

Discussion

The decline in abundance and diversity in Hawaiian *Hylaeus* compared to recent collections is striking and disturbing. Although quantitative measures are highly imperfect for a survey such as this, they are nonetheless illustrative. Effort has been much greater than in 1999, especially on O‘ahu, but the relative number of specimens obtained is well below that of the earlier period (Table 4). Indeed, the two days of collecting at Pōhakuloa Training Area in 1999 alone found 92 individuals of 8 species, 40% of the total for 2012.

A major consideration for future *Hylaeus* surveys is the extreme difficulty in finding many species reliably even in areas where they are present. Day-to-day and even hour-to-hour changes in weather easily affect findings. Several of the species in this survey – notably *H. makaha*, *H. mamo*, and *H. ombrias* – were only found as a result of somewhat arbitrary decisions to look in a certain place at a certain time, often after having visited the same site repeatedly (even on the same day). This element of random chance is frustrating for any attempt to conduct a thorough and standardized survey, yet it is frequently the only way that some species are detected at all.

The current severe drought in Hawai‘i, which has been ongoing since 2010 and particularly affects the eastern islands, may be partly to blame for the low numbers of bees. In 1998 and 1999, the start of the previous collecting period, there was also a drought, but

Table 4. Comparison of effort and results in 1999 and 2012 surveys.

	Hawai‘i		O‘ahu	
	1999	2012	1999	2012
days	22	63	8	63
species	17	15	5	10
specimens*	160	250	56	96

* - Hawai‘i numbers exclude the abundant *H. difficilis*

it was much less intense and many plants seemed to react to stress by increased flowering during that year. With the current drought now three years old, many plants may be too stressed to produce flowers and particularly nectar. However, this cannot be the explanation for everything. O‘ahu received an average amount of rain this year, including several large storms, and even during the summer it rained twice during visits to Ka‘ena Point; indeed, the plants there looked relatively healthy. Yet the *Hylaeus* that had been abundant there a few years ago are now almost completely gone.

In the upland areas of Hawai‘i, the naio thrips, *Klambothrips myopori* (Thysanoptera: Phlaeothripidae), may be having a severe impact on *Hylaeus* populations by reducing flower production and causing plant mortality. First detected on Hawai‘i in 2008, it has since spread throughout most of the area of high-density *Myoporum sandwicense* forest, between Mauna Kea, Mauna Loa, and Hualalai. The hardest-hit area is in Pōhakuloa, where mortality is extremely high at some sites. Even where infestations are relatively low, flowering is usually much reduced compared to healthy plants. Earlier work on pollen usage by *Hylaeus* (K. Magnacca, unpublished data) found *Myoporum* to be unusual in that is was both heavily used as a pollen source, and a "nectar plant" in the sense that a disproportionate number of bees collected on it were carrying pollen from another type of plant. Thus, it may play an important role both as a food plant during brood rearing and in maintaining adult populations through seasons when other flowers are not available. *Myoporum* flowering and *Hylaeus* abundance and diversity were correlated – Pu‘u Wa‘awa‘a and PTA Areas 22 and 23 (formerly highly diverse sites) were heavily affected by thrips and had little flowering and few bees, while Ka‘ohe GMA and PTA Areas 4 and 21 had only light infestations, moderate flowering, and had *H. flavipes* and *H. kona* present. Despite the extremely dry conditions, there was heavy flowering of *Euphorbia olowaluana* and *Bidens menziesii*, two other plants favored in previous years (Daly and Magnacca 2003), yet bees were largely absent from both in areas where *Myoporum* was severely affected.

It is unknown to what extent *Hylaeus* may be able to survive extended periods of famine. To be sure, this is hardly the first severe drought to strike the islands, and the role of *Myoporum* as a moderating influence is as yet unknown. The question is whether populations such as *H. anthracinus* and *H. flavipes* at South Point, already reduced by habitat loss and direct human impacts, will be able to persist until their food plants resprout or regrow. In many cases, there are no nearby populations that could act as dispersal sources if isolated populations do die out.

The Hawai‘i population of *H. anthracinus* is the only target taxon found in healthy numbers, and even it is limited to an extremely narrow distribution that could easily be threatened by the introduction of a new alien competitor, expansion of ant populations, or even a single stochastic event such as a major tsunami. The disjunct population in Ka‘ū is in an even more perilous situation, inhabiting a short stretch of coastline less than 500 m long with few resources. There is only a single montane record of this otherwise coastal species, from Pōhakuloa Training Area (Magnacca 2007b). The precise locality is not known, but it was found resting in a fruit capsule of *Kadua coriacea*, which typically occurs in open *Metrosideros* treeland, a generally poor habitat for *Hylaeus*. While some other typical coastal species occur in the broader area, namely *H. flavipes* and *H. ombrias*, no additional *H. anthracinus* specimens have been found, and it is questionable whether a permanent breeding population exists there. These factors, combined with the lack of significant genetic divergence between other disjunct populations and relative abundance of *H. anthracinus* along the Kona-Kohala coast, indicate that resources would be best utilized in preserving and expanding coastal populations. Given the high densities found in the present restricted locations, reintroduction via translocation into suitable restored coastal and lowland habitats may be a viable conservation option, with little impact on the source population.

The extensive reliance on the introduced tree heliotrope, *Heliotropium foertherianum* (=*Tournefortia argentea*), as a floral resource by *H. anthracinus* and *H. longiceps* is a critical discovery of this survey. Along most of the Kona-Kohala coast, this was the dominant flower visited by *H. anthracinus*, which was never found at sites where only *Scaevola taccada* was present. As a non-native tree which is capable of crowding out rare native coastal species, *He. foertherianum* is sometimes targeted for removal by resource managers. In areas where native plant diversity and abundance is high and capable of supporting bees on their own, or where intensive active management is occurring to promote such conditions, removal is warranted. This is particularly the case where *He. foertherianum* is forming dense stands, which appear to provide suitable habitat for invasive ant species such as *Anoplolepis gracilipes* that exclude *Hylaeus*. Total removal of *He. foertherianum* from low-diversity areas where it is relatively non-invasive, solely for the sake of removing alien plants, would be seriously detrimental to the continued existence of *Hylaeus* at such sites; however, thinning dense stands could potentially help in certain conditions, by making an area too dry for ants to persist. Therefore, we urge caution and judgement be used when removal of *He. foertherianum* is considered. Both short and long term outcomes may be difficult to predict.

For montane species, development is not a serious issue since they occur primarily or exclusively in areas remote from direct human impacts and often at sites that are already at least semi-protected, such as forest reserves. However, the coastal species, including *H. anthracinus*, *H. flavipes*, *H. longiceps*, and *H. ombrias* (as well as *H. assimulans*, which was not found in this survey but occurs in similar situations on Maui), frequently live in areas of high human disturbance. Both *H. anthracinus* and *H. longiceps* were found adjacent to major resorts or even on their immediate frontage. While this indicates that native bees are capable of living in proximity to development, their restricted distributions underscore the potential for rapid change. For example, *H. anthracinus* is found at some Kohala resorts but not others, and both *H. anthracinus* and *H. longiceps* are found close to Turtle Bay but not at it, despite the presence of (to human eyes) suitable habitat in all cases. This suggests that other factors may be at play, such as differing groundskeeping methods that may affect the availability of nesting sites.

Ants have had enormous impacts on the native invertebrate fauna of Hawai‘i, and the distribution of the tramp ant species that usually have the greatest impact is often closely related to human disturbance. The effect of various species of ants on *Hylaeus* is not fully understood. From their frequent co-occurrence, *Hylaeus* can evidently tolerate the presence of *Ochetellus glaber* in large numbers, and *Pheidole megacephala* in at least moderate abundance. However, the results of this survey indicate that *Anoplolepis gracilipes* (long-legged ant or yellow crazy ant) and *Linepithema humile* (Argentine ant) appear to severely reduce or entirely exclude *Hylaeus* where they occur in noticeable numbers (see Appendix). *Linepithema* has been documented to directly prey on *Hylaeus* larvae (Cole et al. 1992), and both species consume large quantities of nectar (Lach 2005), depriving survivors of a food source. *Anoplolepis* probably plays a major role in limiting the distribution of bees in coastal and lowland habitats, and the expanding range of *Linepithema* has significantly decreased the available montane mesic and dry habitat, particularly at PTA and Hawai‘i Volcanoes NP.

An important issue for *Hylaeus* conservation that has not yet been fully explored is the possibility of cryptic species. *Hylaeus anthracinus* almost certainly consists of three cryptic species based on island populations – Hawai‘i, Maui + Kaho‘olawe, and O‘ahu + Moloka‘i –

which are highly divergent genetically and non-monophyletic with respect to *H. flavifrons* of Kauaʻi (Magnacca and Brown 2010). Most other species are genetically different between islands as well, including *H. flavipes* and *H. laetus*, but whether these should be considered as a multiple species or one is less clear-cut. Nevertheless, they are clearly distinct evolutionary units that have been isolated for a considerable time. With no clear-cut definition of what may constitute a species where genetic differentiation is moderate to high and morphological differences are absent, this problem may remain unresolved for some time.

In conclusion, the immediate outlook for the candidate and rare *Hylaeus* species is poor. It is difficult to draw conclusions from a single year's data that can be colored by unusual weather events and other stochastic factors. However, elements of these results – particularly the stark drop in bee diversity in montane dry forest on Hawaiʻi despite relatively strong seasonal flowering in several favored host plants – appear to reflect longer term trends of invasive species and climate change that are difficult or impossible to reverse. Preservation of native pollinator diversity in Hawaiʻi will require the development of new techniques in response to these challenges, including survey methods for detection of extremely rare species, adaptive management of tree heliotrope, and reintroduction of bees into restored habitat.

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Appendix

Sampling sites and bee records from Hawai‘i and O‘ahu. Dates indicate the first visit when a GPS point was taken; many were visted multiple times. Sites are numbered by location:

001–299	Hawai‘i coastal
300–499	Kona mauka and Mauna Kea
500–599	Ka‘ū mauka and windward
600–799	O‘ahu

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
001	5Q	204677	2216381	20.02176	-155.82273	coast	12/23/2011	Spencer BP	Heliotropium		y														few trees
002	5Q	204571	2215724	20.01581	-155.82363	coast	12/23/2011	Mauumae	Ipomoea									y							
003	5Q	204436	2215746	20.01599	-155.82492	coast	12/23/2011	Mauumae	Heliotropium																
004	5Q	204367	2215284	20.01181	-155.82551	coast	12/24/2011	Mauna Kea Beach Hotel	Heliotropium																
005	5Q	204384	2215246	20.01147	-155.82534	coast	12/24/2011	Mauna Kea Beach Hotel	Heliotropium																Lasioglossum on Scaevola
006	5Q	204232	2214841	20.00779	-155.82672	coast	12/24/2011	Mauna Kea Beach Hotel	Heliotropium					y	y										
007	5Q	204240	2214803	20.00745	-155.82664	coast	12/24/2011	Mauna Kea Beach Hotel	Heliotropium		y			y	y										Lasioglossum on Scaevola
008	5Q	204256	2214263	20.00257	-155.82640	coast	12/24/2011	Mauna Kea Beach Hotel	Heliotropium		y			y											
009	5Q	204148	2214006	20.00024	-155.82739	coast	12/24/2011	Mauna Kea Beach Hotel	Myoporum																naio papa, heavily damaged by Klambothrips
010	5Q	204128	2213900	19.99928	-155.82757	coast	12/24/2011	Mauna Kea Beach Hotel	Myoporum																naio papa, moderate damage from Klambothrips
011	5Q	203694	2211104	19.97398	-155.83126	coast	12/23/2011	Puako	Heliotropium																only checked immediate area
012	5Q	202639	2210872	19.97173	-155.84129	coast	12/23/2011	Puako	Heliotropium	anthracinus				y	y										all bees seen in June but not January
013	5Q	202536	2210857	19.97157	-155.84228	coast	12/23/2011	Puako	Heliotropium		y														
014	5Q	202403	2210699	19.97012	-155.84352	coast	12/23/2011	Puako	Heliotropium																
015	5Q	201894	2210411	19.96745	-155.84833	coast	12/23/2011	Puako	Heliotropium	anthracinus				y	y										all bees seen in June but not January
016	5Q	200626	2209157	19.95594	-155.86023	coast	12/23/2011	Holoholokai park	Heliotropium	anthracinus															
017	5Q	200591	2209084	19.95527	-155.86055	coast	12/23/2011	Holoholokai park	Heliotropium	anthracinus															
018	5Q	200536	2209035	19.95482	-155.86107	coast	12/23/2011	Fairmont Orchid	Heliotropium	anthracinus															
019	5Q	200487	2208871	19.95334	-155.86151	coast	12/23/2011	Fairmont Orchid	Heliotropium	anthracinus															
020	5Q	200217	2208603	19.95087	-155.86405	coast	12/23/2011	Fairmont Orchid	Heliotropium	anthracinus															
021	5Q	200132	2208493	19.94987	-155.86484	coast	12/23/2011	Fairmont Orchid	Heliotropium	anthracinus															
022	5Q	199950	2208337	19.94843	-155.86654	coast	12/23/2011	Mauna Lani	Heliotropium															Brachymyrmex	
023	5Q	199614	2207883	19.94428	-155.86968	coast	12/23/2011	Mauna Lani	Heliotropium																
024	5Q	198829	2207544	19.94110	-155.87712	coast	12/30/2011	Mauna Lani	Heliotropium					y	y										
025	5Q	198858	2207325	19.93913	-155.87680	coast	12/30/2011	Mauna Lani	Heliotropium					y	y										
026	5Q	198829	2206832	19.93467	-155.87700	coast	12/30/2011	Mauna Lani	Scaevola														y	Ochetellus glaber	
027	5Q	198419	2206704	19.93346	-155.88089	coast	12/30/2011	Mauna Lani	Scaevola																also Heliotropium
028	5Q	197624	2206171	19.92852	-155.88839	coast	12/29/2011	Hilton Waikoloa	Heliotropium	anthracinus				y			y	y							Ceratina in June on Vitex
029	5Q	197716	2206413	19.93072	-155.88755	coast	12/29/2011	Ke Kailani	Scaevola	difficilis							y								
030	5Q	197852	2206596	19.93239	-155.88628	coast	12/29/2011	Ke Kailani	Heliotropium					y	y		y	y							
031	5Q	197689	2206015	19.92713	-155.88774	coast	12/29/2011	Hilton Waikoloa	Heliotropium	anthracinus, difficilis			y												
032	5Q	197620	2205867	19.92578	-155.88838	coast	12/29/2011	Hilton Waikoloa	Heliotropium					y	y			y							
033	5Q	197585	2205874	19.92583	-155.88872	coast	12/29/2011	Hilton Waikoloa	Heliotropium	anthracinus, difficilis													y		
034	5Q	197485	2205848	19.92559	-155.88967	coast	12/29/2011	Hilton Waikoloa	Heliotropium	anthracinus															
035	5Q	197416	2205814	19.92526	-155.89031	coast	12/29/2011	Hilton Waikoloa	Pluchea	anthracinus															
036	5Q	197367	2205731	19.92451	-155.89077	coast	12/29/2011	Hilton Waikoloa	Heliotropium	anthracinus															
037	5Q	197338	2205696	19.92419	-155.89104	coast	12/29/2011	Hilton Waikoloa	Heliotropium	anthracinus															ants carrying dead headless Hylaeus
038	5Q	197333	2205644	19.92372	-155.89108	coast	12/29/2011	Hilton Waikoloa	Scaevola	anthracinus								y							
039	5Q	197390	2205481	19.92226	-155.89051	coast	12/29/2011	Hilton Waikoloa	Heliotropium	anthracinus								y							
040	5Q	197375	2205304	19.92066	-155.89062	coast	12/29/2011	Kolea	Heliotropium					y	y										Pachodynerus present, not seen elsewhere
041	5Q	197350	2205235	19.92003	-155.89086	coast	12/29/2011	Kolea	Heliotropium	anthracinus								y							
042	5Q	197357	2205212	19.91982	-155.89079	coast	12/29/2011	Kolea	Heliotropium	anthracinus															
043	5Q	197407	2205089	19.91872	-155.89029	coast	12/29/2011	Kolea	Scaevola								y	y							Heliotropium nearby with no bees
044	5Q	197395	2205144	19.91922	-155.89041	coast	12/30/2011	Kolea	Scaevola	anthracinus							y								
045	5Q	197401	2205111	19.91892	-155.89034	coast	12/30/2011	Kolea	Scaevola	anthracinus								y							
046	5Q	197425	2205065	19.91851	-155.89011	coast	12/30/2011	Kolea	Scaevola							y	y	y			y				
047	5Q	197487	2204400	19.91252	-155.88941	coast	12/30/2011	Anaehoomalu Bay	Scaevola							y	y	y							
048	5Q	197119	2204231	19.91093	-155.89289	coast	12/30/2011	Anaehoomalu Bay	Scaevola		y													Ochetellus glaber	
049	5Q	196902	2204116	19.90987	-155.89495	coast	12/30/2011	Anaehoomalu Bay	Scaevola														y		
050	5Q	196617	2204041	19.90914	-155.89765	coast	12/30/2011	Anaehoomalu Bay	Scaevola														y		Anoplolepis very abundant
051	5Q	196477	2204026	19.90899	-155.89899	coast	12/30/2011	Anaehoomalu Bay	Heliotropium									y					y		Anoplolepis very abundant
052	5Q	187179	2195735	19.83269	-155.98630	coast	12/30/2011	Kona Village	Heliotropium				y												
053	5Q	186921	2195499	19.83052	-155.98872	coast	12/30/2011	Kona Village	Heliotropium																
054	5Q	186246	2195057	19.82642	-155.99508	coast	12/30/2011	Four Seasons Hualalai	Heliotropium					y	y		y	y							Scaevola also present, with Ceratina and Pithitis
055	5Q	186078	2194548	19.82181	-155.99660	coast	12/30/2011	Four Seasons Hualalai	Heliotropium					y	y			y							
056	4Q	814236	2194196	19.81858	-156.00047	coast	12/30/2011	Kukio	Heliotropium	difficilis				y											
057	4Q	814198	2194095	19.81768	-156.00084	coast	12/30/2011	Kukio	Heliotropium	difficilis				y											
058	4Q	814233	2193858	19.81553	-156.00056	coast	12/30/2011	Kukio	Heliotropium	difficilis				y											
059	5Q	195670	2201646	19.88738	-155.90629	coast	1/21/2012	Keawaiki	Heliotropium																
060	5Q	195444	2201416	19.88527	-155.90841	coast	1/21/2012	Keawaiki	Scaevola									y							also Ipomoea pes-caprae
061	5Q	195255	2201419	19.88526	-155.91022	coast	1/21/2012	Keawaiki	Heliotropium	difficilis			y					y							
062	4Q	813624	2193232	19.80997	-156.00646	coast	1/21/2012	Kua Bay	Heliotropium	difficilis	y														

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
063	4Q	813663	2193325	19.81081	-156.00608	coast	1/21/2012	Kua Bay	Heliotropium	difficilis															
064	4Q	813701	2193366	19.81118	-156.00571	coast	1/21/2012	Kua Bay	Heliotropium	difficilis															
065	4Q	813646	2193411	19.81159	-156.00623	coast	1/21/2012	Kua Bay	Scaevola	difficilis						y									
066	4Q	808494	2184421	19.73127	-156.05684	coast	1/5/2012	Keahole Point	Heliotropium	difficilis						y		y							
067	4Q	808390	2184390	19.73101	-156.05784	coast	1/5/2012	Keahole Point	Heliotropium	difficilis				y											
068	4Q	808298	2184348	19.73064	-156.05873	coast	1/5/2012	Keahole Point	Heliotropium	difficilis				y											
069	4Q	808266	2184287	19.73010	-156.05904	coast	1/5/2012	Keahole Point	Heliotropium	difficilis				y											
070	4Q	808172	2184219	19.72950	-156.05995	coast	1/5/2012	Keahole Point	Heliotropium	difficilis				y											
071	4Q	808176	2183991	19.72744	-156.05995	coast	1/5/2012	Keahole Point	Heliotropium	difficilis				y											
072	4Q	808365	2183688	19.72467	-156.05819	coast	1/5/2012	Keahole Point	Heliotropium	anthracinus, difficilis				y											
073	4Q	808396	2183642	19.72426	-156.05791	coast	1/5/2012	Keahole Point	Heliotropium	anthracinus, difficilis				y											
074	4Q	808424	2183610	19.72397	-156.05764	coast	1/5/2012	Keahole Point	Heliotropium	anthracinus, difficilis				y											
075	4Q	808502	2183496	19.72292	-156.05693	coast	1/5/2012	Keahole Point	Heliotropium	anthracinus, difficilis				y											
076	4Q	808560	2183406	19.72210	-156.05638	coast	1/5/2012	Keahole Point	Heliotropium	anthracinus, difficilis				y		y		y							
077	4Q	808594	2183356	19.72164	-156.05606	coast	1/6/2012	Keahole Point	Scaevola	anthracinus				y											
078	4Q	808759	2183202	19.72023	-156.05452	coast	1/6/2012	Keahole Point	Heliotropium	anthracinus, difficilis				y											
079	4Q	808861	2183106	19.71935	-156.05356	coast	1/6/2012	Keahole Point	Heliotropium	anthracinus, difficilis				y											
080	4Q	808980	2183028	19.71862	-156.05244	coast	1/6/2012	Keahole Point	Heliotropium	anthracinus, difficilis	y		y	y				y							
081	4Q	809169	2182897	19.71741	-156.05066	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis	y		y	y		y		y						Ochetellus glaber	
082	4Q	809308	2182744	19.71601	-156.04936	coast	1/6/2012	Ooma	Scaevola	anthracinus, difficilis				y											
083	4Q	809377	2182649	19.71514	-156.04872	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
084	4Q	809356	2182747	19.71603	-156.04890	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y			y	y							
085	4Q	809352	2182529	19.71406	-156.04898	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
086	4Q	809357	2182492	19.71373	-156.04894	coast	1/6/2012	Ooma	Scaevola	anthracinus, difficilis	y			y											
087	4Q	809381	2182350	19.71244	-156.04873	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
088	4Q	809429	2182154	19.71066	-156.04830	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
089	4Q	809465	2181988	19.70917	-156.04800	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
090	4Q	809484	2181810	19.70756	-156.04785	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
091	4Q	809483	2181711	19.70666	-156.04787	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
092	4Q	809463	2181252	19.70252	-156.04814	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis	y			y											
093	4Q	809485	2181166	19.70174	-156.04794	coast	1/6/2012	Ooma	Heliotropium	anthracinus, difficilis				y											
094	4Q	809630	2180812	19.69852	-156.04662	coast	1/6/2012	Kohanaiki	Heliotropium	anthracinus, difficilis				y											
095	4Q	809760	2180575	19.69636	-156.04541	coast	1/6/2012	Kohanaiki	Heliotropium														y		
096	4Q	809826	2180532	19.69597	-156.04480	coast	1/6/2012	Kohanaiki	Heliotropium	anthracinus, difficilis				y											
097	4Q	809864	2180409	19.69485	-156.04445	coast	1/6/2012	Kohanaiki	Heliotropium	anthracinus, difficilis				y											
098	4Q	809885	2180293	19.69380	-156.04427	coast	1/6/2012	Kohanaiki	Heliotropium	anthracinus				y									y		
099	5Q	193332	2197829	19.85257	-155.92796	coast	1/20/2012	Kiholo Bay	Heliotropium					y	y										
100	5Q	193619	2198080	19.85487	-155.92527	coast	1/20/2012	Kiholo Bay	Heliotropium																
101	5Q	193957	2198093	19.85504	-155.92205	coast	1/20/2012	Kiholo Bay	Scaevola									y							
102	5Q	192020	2197575	19.85006	-155.94044	coast	1/20/2012	Luahinewai	Scaevola	anthracinus, difficilis	y														
103	5Q	191949	2197573	19.85004	-155.94111	coast	1/20/2012	Luahinewai	Heliotropium	anthracinus, difficilis	y			y											
104	5Q	190681	2197816	19.85203	-155.95325	coast	1/20/2012	Kiholo dunes	Heliotropium	anthracinus, difficilis	y			y										Technomyrmex albipes	
105	5Q	190635	2197809	19.85196	-155.95369	coast	1/20/2012	Kiholo dunes	Ipomoea	anthracinus															
106	5Q	190399	2197820	19.85202	-155.95594	coast	1/20/2012	Kiholo dunes	Heliotropium	anthracinus, difficilis				y											
107	5Q	190349	2197830	19.85211	-155.95642	coast	1/20/2012	Kiholo dunes	Ipomoea									y							
108	5Q	189132	2197502	19.84895	-155.96797	coast	1/20/2012	Kaupulehu dunes	Heliotropium	difficilis	y			y											
109	5Q	188638	2197278	19.84685	-155.97265	coast	1/20/2012	Kaupulehu dunes	Heliotropium	difficilis															
110	5Q	188556	2197269	19.84676	-155.97342	coast	1/20/2012	Kaupulehu dunes	Heliotropium	difficilis															
111	4Q	812771	2175197	19.64735	-156.01762	coast	1/13/2012	Old Kona Airport	Heliotropium	difficilis				y	y				y						
112	4Q	812850	2175242	19.64775	-156.01687	coast	1/13/2012	Old Kona Airport	Heliotropium	difficilis				y	y		y		y						Ceratina on Scaevola
113	4Q	812996	2175135	19.64676	-156.01550	coast	1/13/2012	Old Kona Airport	Heliotropium	difficilis				y	y				y						
114	4Q	813108	2175044	19.64592	-156.01444	coast	1/13/2012	Old Kona Airport	Heliotropium	difficilis				y	y				y						
115	4Q	813566	2174777	19.64344	-156.01012	coast	1/13/2012	Old Kona Airport	Scaevola								y								
116	4Q	813662	2174747	19.64315	-156.00921	coast	1/13/2012	Old Kona Airport	Heliotropium	difficilis			y												
117	4Q	813704	2174670	19.64245	-156.00883	coast	1/13/2012	Old Kona Airport	Heliotropium	difficilis								y							
118	4Q	813807	2174628	19.64205	-156.00785	coast	1/13/2012	Old Kona Airport	Heliotropium	difficilis				y				y	y						
119	5Q	185595	2174311	19.63910	-155.99779	coast	1/13/2012	Kailua Harbor	Heliotropium					y											
120	5Q	185662	2174392	19.63984	-155.99717	coast	1/13/2012	Kailua Harbor	Heliotropium					y											
121	5Q	185903	2174390	19.63986	-155.99487	coast	1/13/2012	Kailua Harbor	Heliotropium					y											
122	5Q	186094	2174051	19.63683	-155.99300	coast	1/13/2012	Kailua Harbor	Heliotropium					y											
123	5Q	189138	2165752	19.56242	-155.96263	coast	1/13/2012	Keauhou marina	Heliotropium																
124	5Q	189004	2164541	19.55147	-155.96370	coast	1/13/2012	Kuamoo	Heliotropium				y	y	y			y	y						one individual of another Megachile seen

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
125	5Q	188701	2164814	19.55388	-155.96663	coast	1/13/2012	Kuamoo	Scaevola														y		
127	4Q	809821	2189856	19.78011	-156.04329	coast	2/2/2012	Mahaiula	Heliotropium	difficilis															
128	4Q	810069	2189992	19.78130	-156.04090	coast	2/2/2012	Mahaiula	Heliotropium	difficilis					y			y							
129	4Q	810267	2189992	19.78127	-156.03902	coast	2/2/2012	Mahaiula	Heliotropium	difficilis								y							
130	4Q	810475	2190095	19.78216	-156.03701	coast	2/2/2012	Mahaiula	Heliotropium	difficilis															
131	4Q	810544	2190282	19.78385	-156.03633	coast	2/2/2012	Mahaiula	Heliotropium	difficilis															
132	4Q	811395	2191121	19.79128	-156.02807	coast	2/2/2012	Makalawena	Heliotropium	difficilis					y										
133	4Q	811625	2191471	19.79441	-156.02583	coast	2/2/2012	Makalawena	Heliotropium	difficilis															
134	4Q	809961	2180246	19.69336	-156.04355	coast	2/3/2012	Kohanaiki	Capparis	anthracinus			y	y											
135	4Q	810074	2180205	19.69298	-156.04249	coast	2/3/2012	Kohanaiki	Heliotropium	anthracinus, difficilis				y										Ochetellus glaber	
136	4Q	810283	2180179	19.69271	-156.04050	coast	2/3/2012	Kohanaiki	Heliotropium	anthracinus, difficilis				y											
137	4Q	810403	2180145	19.69238	-156.03936	coast	2/3/2012	Kohanaiki	Myoporum	anthracinus			y	y											
138	4Q	810449	2180057	19.69158	-156.03893	coast	2/3/2012	Kohanaiki	Heliotropium	anthracinus			y	y											
139	4Q	810508	2180028	19.69131	-156.03838	coast	2/3/2012	Kohanaiki	Heliotropium	anthracinus, difficilis			y	y				y							
140	4Q	810603	2180046	19.69145	-156.03748	coast	2/3/2012	Kohanaiki	Heliotropium	anthracinus, difficilis			y	y											
141	4Q	810688	2179996	19.69099	-156.03667	coast	2/3/2012	Kohanaiki	Heliotropium	anthracinus, difficilis			y	y											
142	4Q	810731	2179937	19.69045	-156.03627	coast	2/3/2012	Kohanaiki	Heliotropium	anthracinus				y											
143	5Q	195345	2145561	19.38114	-155.90028	coast	2/3/2012	Hookena	Heliotropium				y	y	y			y	y						
144	5Q	195193	2146178	19.38669	-155.90183	coast	2/3/2012	Hookena	Heliotropium					y	y			y	y						
145	5Q	194184	2122539	19.17317	-155.90766	coast	2/3/2012	Honomalino	Heliotropium																
146	5Q	236752	2117677	19.13524	-155.50257	coast	3/8/2012	Punaluu	Sida								y	y							also Waltheria and a few Jacquemontia present
147	5Q	236505	2117731	19.13569	-155.50492	coast	3/8/2012	Punaluu	Scaevola									y							
148	5Q	236429	2117446	19.13311	-155.50561	coast	3/8/2012	Punaluu	Sida																
149	5Q	236406	2117340	19.13215	-155.50581	coast	3/8/2012	Punaluu	Heliotropium					y											
150	5Q	236036	2117176	19.13063	-155.50931	coast	3/8/2012	Punaluu	Heliotropium					y											
151	5Q	231672	2112294	19.08598	-155.55009	coast	3/15/2012	Whittington	Heliotropium		y			y					y						
152	5Q	231983	2112296	19.08603	-155.54713	coast	3/15/2012	Whittington	Heliotropium					y					y						
153	5Q	217536	2093183	18.91154	-155.68155	coast	3/15/2012	South Point	Tribulus	flavipes															also Jacquemontia and Sida
154	5Q	226230	2099824	18.97267	-155.60001	coast	5/23/2012	Kamilo	Heliotropium	difficilis															
155	5Q	225962	2099497	18.96969	-155.60251	coast	5/23/2012	Kamilo	Euphorbia	difficilis							y								
156	5Q	225989	2099475	18.96949	-155.60225	coast	5/23/2012	Kamilo	Heliotropium	difficilis							y								
157	5Q	225979	2099602	18.97063	-155.60237	coast	5/23/2012	Kamilo	Myoporum	difficilis							y								
158	5Q	225988	2099650	18.97107	-155.60229	coast	5/23/2012	Kamilo	Sida	difficilis							y								
159	5Q	226041	2099745	18.97193	-155.60179	coast	5/23/2012	Kamilo	Melanthera	difficilis															
160	5Q	201319	2210220	19.96564	-155.85379	coast	6/5/2012	Puako	Heliotropium																marked only as a site to return to
161	5Q	197423	2205602	19.92336	-155.89022	coast	6/5/2012	Hilton Waikoloa	Heliotropium	anthracinus								y							Pithitis on adjacent Scaevola; apparently little mixing between bees on plants
162	5Q	197575	2206216	19.92892	-155.88887	coast	6/5/2012	Hilton Waikoloa	Heliotropium	anthracinus															
163	5Q	200963	2209741	19.96126	-155.85710	coast	6/5/2012	Fairmont Orchid	Heliotropium					y											
164	5Q	200890	2209618	19.96014	-155.85778	coast	6/5/2012	Fairmont Orchid	Heliotropium	anthracinus				y											
165	5Q	200845	2209425	19.95839	-155.85818	coast	6/5/2012	Fairmont Orchid	Heliotropium	anthracinus				y											
166	5Q	200781	2209274	19.95702	-155.85877	coast	6/5/2012	Puako	Scaevola	anthracinus															
167	5Q	200357	2208579	19.95067	-155.86270	coast	6/5/2012	Fairmont Orchid	Heliotropium	anthracinus				y											
168	5Q	200106	2208447	19.94945	-155.86508	coast	6/5/2012	Fairmont Orchid	Heliotropium	anthracinus															
169	4Q	810733	2179894	19.69007	-156.03625	coast	6/6/2012	Fairmont Orchid	Heliotropium																
170	4Q	811376	2179442	19.68589	-156.03021	coast	6/6/2012	KAHO	Argemone								y								
171	4Q	811211	2178934	19.68133	-156.03186	coast	6/6/2012	KAHO	Scaevola					y				y							
172	4Q	811363	2178688	19.67908	-156.03045	coast	6/6/2012	KAHO	Heliotropium					y											
173	4Q	811823	2178194	19.67455	-156.02616	coast	6/6/2012	KAHO	Heliotropium					y											
174	4Q	811854	2177817	19.67115	-156.02593	coast	6/6/2012	KAHO	Heliotropium					y											
175	4Q	811800	2177769	19.67072	-156.02645	coast	6/6/2012	KAHO	Heliotropium	difficilis				y					y						
176	4Q	811740	2177491	19.66822	-156.02707	coast	6/6/2012	KAHO	Heliotropium	difficilis															
177	4Q	811633	2177377	19.66721	-156.02810	coast	6/6/2012	KAHO	Heliotropium																
178	4Q	808223	2183910	19.72671	-156.05952	coast	6/6/2012	Keahole Point	Heliotropium	anthracinus, difficilis															
179	4Q	808246	2183856	19.72621	-156.05930	coast	6/6/2012	Keahole Point	Heliotropium	anthracinus, difficilis														Pseudomyrmex	
180	4Q	808295	2183763	19.72536	-156.05885	coast	6/6/2012	Keahole Point	Heliotropium	anthracinus, difficilis															
181	5Q	191327	2156914	19.48299	-155.94034	coast	6/7/2012	Kaawaloa	Heliotropium					y				y	y	y					gray Megachile, rare, couldn't catch
182	5Q	191474	2156720	19.48126	-155.93891	coast	6/7/2012	Kaawaloa	Heliotropium					y						y				Pheidole megacephala, Ochetellus, Camponotus	gray Megachile, rare, couldn't catch
183	5Q	191845	2156458	19.47896	-155.93534	coast	6/7/2012	Kaawaloa	Capparis																
184	5Q	193204	2154888	19.46499	-155.92215	coast	6/7/2012	Keei	Scaevola					y				y					y		
185	5Q	193097	2154790	19.46410	-155.92315	coast	6/7/2012	Keei	Heliotropium					y				y					y		

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
186	5Q	194348	2149557	19.41706	-155.91041	coast	6/7/2012	PUHO	Sesbania					y											
187	5Q	194559	2149432	19.41596	-155.90838	coast	6/7/2012	PUHO	diverse					y				y							
188	5Q	194553	2149400	19.41567	-155.90843	coast	6/7/2012	PUHO	Heliotropium					y				y							
189	5Q	217560	2093173	18.91145	-155.68132	coast	7/9/2012	Kalae	Tribulus	flavipes										y					
190	5Q	218989	2093778	18.91711	-155.66786	coast	7/9/2012	Kaulana	Scaevola	anthracinus							y			y					
191	5Q	219322	2093771	18.91709	-155.66470	coast	7/9/2012	Kaulana	Heliotropium	anthracinus, difficilis													y		
192	5Q	219426	2094107	18.92014	-155.66376	coast	7/9/2012	Kaulana	Heliotropium	flavipes				y											
193	5Q	220057	2094269	18.92169	-155.65779	coast	7/9/2012	Kaulana	Sida											y					
194	5Q	221249	2095780	18.93549	-155.64670	coast	7/9/2012	Mahana	Heliotropium					y											also Jacquemontia and Scaevola
195	5Q	221651	2095780	18.93555	-155.64289	coast	7/9/2012	Mahana	Heliotropium	difficilis														Paratrechina longicornis	ants very abundant
196	5Q	222528	2096283	18.94021	-155.63464	coast	7/10/2012	Mahana	Heliotropium	difficilis														Pheidole megacephala	
197	5Q	222694	2096788	18.94479	-155.63314	coast	7/10/2012	Mahana	Sida																
198	5Q	223261	2097513	18.95141	-155.62785	coast	7/10/2012	Mahana	Sida																
199	5Q	223765	2098679	18.96200	-155.62324	coast	7/10/2012	Kaalualu	Heliotropium					y	y										
200	5Q	223980	2099125	18.96606	-155.62126	coast	7/10/2012	Kaalualu	Heliotropium																
201	5Q	224971	2099510	18.96966	-155.61191	coast	7/10/2012	Kaalualu	Heliotropium	difficilis	y			y						y					Lasioglossum and Megachile on adjacent Scaevola, not on Heliotropium
202	5Q	225145	2099209	18.96698	-155.61022	coast	7/10/2012	Kaalualu	Heliotropium																
203	4Q	810883	2179743	19.68868	-156.03485	coast	10/16/2012	KAHO																	
301	5Q	202176	2184919	19.73741	-155.84153	1304	1/26/2012	Puu Waawaa	Sophora	pele														Ochetellus glaber	
302	5Q	202108	2184940	19.73759	-155.84218	1306	1/27/2012	Puu Waawaa	Sophora	pele															
303	5Q	202899	2188663	19.77131	-155.83524	1183	1/27/2012	Puu Waawaa	Sophora																
304	5Q	228238	2195022	19.83239	-155.59456	2253	3/14/2012	Kaohe	Santalum					y											
305	5Q	232029	2198177	19.86139	-155.55884	2374	3/14/2012	Kaohe	Styphelia																
306	5Q	226452	2193561	19.81895	-155.61138	2000	3/14/2012	Kaohe	Euphorbia																
307	5Q	226094	2193330	19.81681	-155.61476	1978	3/14/2012	Kaohe	Euphorbia																
308	5Q	237158	2185338	19.74618	-155.50808	2070	3/14/2012	Puu Koohi	Euphorbia																
309	5Q	222724	2184704	19.73847	-155.64562	1667	4/11/2012	PTA Area 22	Euphorbia					y										Linepithema humile	
310	5Q	222704	2184625	19.73775	-155.64580	1672	4/11/2012	PTA Area 22	Euphorbia					y										Linepithema humile	
311	5Q	222610	2184716	19.73856	-155.64670	1666	4/11/2012	PTA Area 22	Euphorbia					y										Linepithema humile	
312	5Q	222501	2184302	19.73481	-155.64768	1653	4/11/2012	PTA Area 22	Euphorbia					y										Linepithema humile	
313	5Q	222471	2184231	19.73417	-155.64795	1657	4/11/2012	PTA Area 22	Euphorbia					y										Linepithema humile	
314	5Q	222526	2184151	19.73345	-155.64743	1662	4/11/2012	PTA Area 22	Euphorbia	laetus				y										Linepithema humile	laetus collected in August
315	5Q	221738	2183817	19.73032	-155.65489	1634	4/11/2012	PTA Area 22	Euphorbia					y										Linepithema humile	
316	5Q	221817	2183791	19.73010	-155.65412	1630	4/11/2012	PTA Area 22	Euphorbia					y										Linepithema humile	
317	5Q	217328	2175117	19.65116	-155.69561	1787	4/23/2012	PTA Area 23	Euphorbia																
318	5Q	221539	2183258	19.72525	-155.65670	1640	4/11/2012	PTA Area 22	Euphorbia	pele, laetus, difficilis				y											Hylaeus collected in August
319	5Q	221325	2183420	19.72668	-155.65876	1630	4/11/2012	PTA Area 22	Euphorbia	laetus, difficilis				y											wood trap nests set out 23 Apr; two used in August
320	5Q	221047	2183522	19.72756	-155.66143	1622	4/11/2012	PTA Area 22	Euphorbia					y											
321	5Q	220758	2183700	19.72913	-155.66421	1614	4/11/2012	PTA Area 22	Euphorbia	difficilis				y											wood trap nests set out 23 Apr; difficilis collected in August
322	5Q	207768	2165220	19.56044	-155.78516	1618	4/17/2012	Lupea	Santalum					y											
323	5Q	208258	2164968	19.55823	-155.78045	1650	4/17/2012	Lupea	Santalum					y											
324	5Q	208659	2164827	19.55702	-155.77661	1681	4/17/2012	Lupea	Metrosideros					y											
325	5Q	210431	2168740	19.59260	-155.76034	1643	4/18/2012	Lupea	Santalum					y											
326	5Q	211132	2169202	19.59687	-155.75374	1700	4/18/2012	Lupea	Styphelia	volcanicus				y											
327	5Q	211180	2169277	19.59755	-155.75329	1705	4/18/2012	Lupea	Metrosideros	volcanicus				y											
328	5Q	213470	2164249	19.55250	-155.73071	2018	4/18/2012	Lupea	Dodonaea	volcanicus				y											
329	5Q	207682	2166200	19.56927	-155.78613	1602	4/17/2012	Lupea	Euphorbia					y										Pheidole megacephala	
330	5Q	216608	2176186	19.66071	-155.70263	1684	4/23/2012	PTA Area 23	Euphorbia	difficilis				y											
331	5Q	217160	2175653	19.65598	-155.69729	1735	4/23/2012	PTA Area 23	Euphorbia	difficilis				y											wood trap nests set out 23 Apr; also difficilis collected on Bidens in August & September
332	5Q	217380	2175550	19.65508	-155.69518	1754	4/23/2012	PTA Area 23	Euphorbia	difficilis				y											
333	5Q	218090	2174522	19.64590	-155.68826	1842	4/23/2012	PTA Area 23	Euphorbia					y											wood trap nests set out 23 Apr
334	5Q	218045	2174487	19.64558	-155.68868	1846	4/23/2012	PTA Area 23	Euphorbia					y											
335	5Q	217980	2174451	19.64524	-155.68930	1842	4/23/2012	PTA Area 23	Santalum					y											
336	5Q	218941	2174859	19.64906	-155.68020	1871	4/25/2012	PTA Area 23	Metrosideros	rugulosus				y											
337	5Q	217157	2175858	19.65783	-155.69735	1726	4/25/2012	PTA Area 23	Euphorbia					y											
338	5Q	230763	2190986	19.79630	-155.56988	2475	5/3/2012	Kaohe	ground	flavipes															
339	5Q	229987	2192393	19.80889	-155.57748	2378	5/3/2012	Kaohe	ground	flavipes															
340	5Q	244313	2203284	19.90914	-155.44234	2051	5/4/2012	Puu Mali	Euphorbia																
341	5Q	244345	2203230	19.90867	-155.44202	2065	5/4/2012	Puu Mali	Euphorbia																
342	5Q	237344	2185321	19.74604	-155.50631	2133	5/8/2012	Puu Koohi	Euphorbia																trap nests set out 8 May

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
343	5Q	237797	2185467	19.74743	-155.50201	2137	5/8/2012	Puu Koohi	Euphorbia																
344	5Q	237973	2185607	19.74871	-155.50035	2126	5/8/2012	Puu Koohi	Euphorbia																also Myoporum
345	5Q	203808	2189363	19.77777	-155.82669	949	5/9/2012	Puu Waawaa	Metrosideros												y				
346	5Q	202308	2184781	19.73618	-155.84025	1305	5/10/2012	Puu Waawaa	Euphorbia																trap nests set out 10 May
347	5Q	201843	2184832	19.73657	-155.84470	1305	5/10/2012	Puu Waawaa	Euphorbia																trap nests set out 10 May
348	5Q	202270	2184898	19.73723	-155.84064	1293	5/10/2012	Puu Waawaa	Euphorbia																
349	5Q	196801	2185410	19.74102	-155.89285	1291	5/10/2012	Puu Waawaa	Metrosideros																
350	5Q	202741	2184581	19.73445	-155.83610	1336	5/10/2012	Puu Waawaa	Santalum																trap nests set out 10 May
351	5Q	242876	2186872	19.76078	-155.45377	2859	5/25/2012	Mauna Kea	ground	difficilis															bees flying over ground
352	5Q	243519	2188369	19.77438	-155.44785	3336	5/25/2012	Mauna Kea	Tetramolopium																none seen at visit 5/25, but reported earlier
353	5Q	210393	2162957	19.54039	-155.75981	1806	6/14/2012	Lupea	Euphorbia																
354	5Q	186070	2185475	19.73993	-155.99514	287	7/6/2012	Palamanui	Metrosideros												y			Pheidole, Plagiolepis, Ochetellus	
355	5Q	186110	2185530	19.74043	-155.99477	280	7/6/2012	Palamanui	Santalum					y											
356	5Q	186095	2185560	19.74069	-155.99492	281	7/6/2012	Palamanui	Euphorbia																
357	5Q	232769	2172349	19.62832	-155.54808	2268	7/11/2012	Puu Koli	Myoporum	kona, rugulosus, difficilis															
358	5Q	233303	2172425	19.62908	-155.54300	2263	7/11/2012	Puu Koli	Myoporum	difficilis															
359	5Q	232800	2183012	19.72459	-155.54931	1913	7/16/2012	Redleg Trail	Euphorbia	difficilis				y											
360	5Q	232709	2181327	19.70937	-155.54994	1935	7/16/2012	Redleg Trail	Myoporum	kona				y											
361	5Q	233233	2179800	19.69565	-155.54472	1967	7/16/2012	Redleg Trail	Myoporum	difficilis				y											
362	5Q	233347	2178669	19.68546	-155.54347	1983	7/16/2012	Redleg Trail	Dodonaea	difficilis				y											difficilis only in August, on Myoporum
363	5Q	232712	2176233	19.66338	-155.54918	2027	7/16/2012	Redleg Trail	Myoporum	flavipes, rugulosus, difficilis				y											difficilis only in August
364	5Q	232164	2176392	19.66474	-155.55442	2030	7/16/2012	Redleg Trail	Myoporum	flavipes, kona, pele, sphecodoides, difficilis				y											
365	5Q	233124	2175700	19.65862	-155.54517	2052	7/16/2012	Redleg Trail	Myoporum	volcanicus, difficilis				y											
366	5Q	233279	2173157	19.63568	-155.54334	2205	7/16/2012	Redleg Trail	Myoporum	kona, difficilis				y											H. kona collected in October
367	5Q	216829	2175889	19.65806	-155.70048	1699	7/17/2012	PTA Area 23	Bidens	laetus, difficilis				y										Linepithema humile	Hylaeus collected in August; also one laetus on Dodonaea
368	5Q	218017	2174500	19.64569	-155.68896	1842	7/17/2012	PTA Area 23	Sophora					y											
369	5Q	216799	2176174	19.66062	-155.70081	1699	7/17/2012	PTA Area 23	Euphorbia					y											
370	5Q	221559	2181841	19.71246	-155.65629	1676	7/17/2012	PTA Area 22	Metrosideros	difficilis				y											
371	5Q	235162	2185316	19.74571	-155.52711	1993	7/17/2012	PTA Area 4	Myoporum	flavipes, kona, coniceps, sphecodoides	y			y											
372	5Q	234546	2183338	19.72777	-155.53270	1954	7/17/2012	PTA Area 4	Rhamnus	difficilis				y											
373	5Q	234435	2183971	19.73347	-155.53385	1972	7/17/2012	PTA Area 4	Myoporum	difficilis				y											
374	5Q	235373	2185719	19.74938	-155.52516	2022	7/25/2012	Mauna Kea SP	Myoporum	flavipes, kona, pele, sphecodoides, difficilis	y														one H. kona exceptionally melanic, median plate and pronotal collar black
375	5Q	238006	2185646	19.74907	-155.50004	2145	7/25/2012	Puu Koohi	Euphorbia	coniceps, difficilis	y			y											
376	5Q	241453	2178758	19.68734	-155.46622	2073	7/25/2012	Puu Huluhulu	Myoporum	difficilis														Linepithema humile	
377	5Q	241404	2178603	19.68593	-155.46667	2063	7/25/2012	Puu Huluhulu	Euphorbia																
378	5Q	222651	2185503	19.74568	-155.64643	1653	8/8/2012	PTA Area 22	Bidens					y											
379	5Q	222179	2185467	19.74528	-155.65093	1625	8/8/2012	PTA Area 22	Bidens	laetus			y	y											
380	5Q	221423	2185559	19.74601	-155.65815	1598	8/8/2012	PTA Area 22	Bidens					y											
381	5Q	220601	2184208	19.73369	-155.66578	1580	8/8/2012	PTA Area 22	Euphorbia	laetus				y											
382	5Q	220369	2183086	19.72353	-155.66782	1632	8/8/2012	PTA Area 22	Metrosideros					y							y				
383	5Q	219733	2183004	19.72270	-155.67387	1624	8/8/2012	PTA Area 22	Metrosideros					y											
384	5Q	220042	2182760	19.72054	-155.67090	1633	8/8/2012	PTA Area 22	Metrosideros					y							y				
385	5Q	232825	2183718	19.73096	-155.54917	1926	8/8/2012	Redleg Trail	Metrosideros	difficilis				y											
386	5Q	234358	2186581	19.75702	-155.53496	1926	8/8/2012	PTA HQ	Myoporum	flavipes, difficilis	y			y											
387	5Q	202925	2188682	19.77149	-155.83500	1190	8/13/2012	Puu Waawaa	Sapindus	connectens															
388	5Q	203136	2189072	19.77504	-155.83305	1109	8/13/2012	Puu Waawaa	Sapindus	connectens				y											
389	5Q	202354	2184767	19.73606	-155.83981	1311	8/14/2012	Potato Hill	Euphorbia					y											
390	5Q	202324	2184728	19.73571	-155.84009	1320	8/14/2012	Potato Hill	Euphorbia					y											
391	5Q	202234	2184885	19.73711	-155.84098	1298	8/14/2012	Potato Hill	Sophora	pele															
392	5Q	201371	2185330	19.74100	-155.84928	1264	8/15/2012	Potato Hill	Sophora	pele				y											
393	5Q	196780	2185165	19.73880	-155.89301	1347	8/15/2012	Halepiula	Myoporum																
394	5Q	202798	2188535	19.77014	-155.83618	1199	8/15/2012	Puu Waawaa	Euphorbia																
395	5Q	217441	2175689	19.65634	-155.69462	1731	9/18/2012	PTA Area 23	Bidens	difficilis				y											
396	5Q	221938	2182177	19.71555	-155.65274	1688	9/18/2012	PTA Area 22	Dubautia					y											
397	5Q	222137	2185483	19.74542	-155.65133	1634	9/19/2012	PTA Area 22	Dubautia	laetus				y											
398	5Q	220553	2185427	19.74469	-155.66642	1575	9/19/2012	PTA Area 22	Sophora	difficilis				y											
399	5Q	221652	2183652	19.72882	-155.65568	1635	9/19/2012	PTA Area 22	Sophora					y											

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
400	5Q	222629	2185604	19.74658	-155.64666	1647	9/19/2012	PTA Area 22	Dubautia	difficilis				y											
401	5Q	231602	2171935	19.62442	-155.55914	2299	9/19/2012	Puu Koli	Myoporum																
402	5Q	235009	2185277	19.74533	-155.52856	1993	10/23/2012	PTA Area 4	Sophora	laetus, difficilis	y			y											
403	5Q	222686	2182725	19.72060	-155.64568	1701	10/24/2012	PTA Area 22	Dubautia	difficilis				y											
404	5Q	217002	2175791	19.65720	-155.69882	1714	10/24/2012	PTA Area 23	Sophora	pele, difficilis				y											
405	5Q	197881	2185300	19.74019	-155.88254	1261	10/26/2012	Puu Waawaa	Sophora	pele				y											
406	5Q	203840	2187740	19.76312	-155.82612	1120	10/26/2012	Puu Waawaa	Zanthoxylum												y				
407	5Q	203029	2188849	19.77301	-155.83403	1165	10/26/2012	Puu Waawaa	Tetramolopium	ombrias, difficilis															
408	5Q	233156	2178368	19.68271	-155.54525	1985	11/28/2012	Redleg Trail	Metrosideros	sphecodoides, difficilis				y											
409	5Q	219391	2181954	19.71318	-155.67697	1622	11/29/2012	PTA Area 22	Dodonaea	difficilis				y											
410	5Q	222975	2183336	19.72616	-155.64301	1709	1/9/2013	PTA Area 22	Euphorbia																
411	5Q	217055	2175732	19.65667	-155.69830	1723	1/9/2013	PTA Area 23	Sophora	difficilis				y											
412	5Q	217271	2175073	19.65076	-155.69614	1781	1/9/2013	PTA Area 23	Euphorbia					y											
501	5Q	251654	2142076	19.35743	-155.36416	931	4/12/2012	Mauna Iki	Metrosideros	difficilis				y											
502	5Q	251881	2141894	19.35582	-155.36197	923	4/12/2012	Mauna Iki	Metrosideros	difficilis				y											
503	5Q	252098	2141687	19.35397	-155.35987	923	4/12/2012	Mauna Iki	Metrosideros	difficilis				y										Pheidole megacephala	
504	5Q	243372	2143690	19.37097	-155.44316	1425	7/10/2012	Kapapala	Leptecophylla	difficilis															
505	5Q	240506	2143574	19.36955	-155.47041	1631	7/10/2012	Kapapala	Dodonaea	difficilis														Linepithema humile	
506	5Q	264736	2179303	19.69517	-155.24433	975	7/11/2012	Saddle	Cheirodendron	pubescens, coniceps, dumetorum															
507	5Q	262626	2178700	19.68947	-155.26437	1129	7/11/2012	Saddle	Cheirodendron	difficilis, pubescens, dumetorum															
508	5Q	255806	2177201	19.67510	-155.32919	1525	7/11/2012	Saddle	Cheirodendron	muranus															
509	5Q	249898	2157770	19.49892	-155.38292	2080	8/10/2012	Mauna Loa Trail	Argyroxiphium	difficilis															volcanicus and inquilinus dead and stuck on inflorescences
510	5Q	249727	2157338	19.49500	-155.38450	2066	8/10/2012	Mauna Loa Trail	Metrosideros	volcanicus, difficilis															
511	5Q	257925	2150927	19.43812	-155.30562	1236	8/10/2012	Kipuka Puaulu	Sapindus	difficilis															
512	5Q	260523	2138641	19.32748	-155.27934	932	8/10/2012	Kipuka Nene	Sesbania	flavipes															
513	5Q	260769	2178522	19.68764	-155.28205	1234	11/30/2012	Saddle	Metrosideros	difficilis															
514	5Q	253923	2176765	19.67094	-155.34709	1619	11/30/2012	Saddle	Metrosideros	rugulosus, difficilis															
515	5Q	247093	2178099	19.68212	-155.41236	1897	1/10/2013	Saddle	Metrosideros	difficilis				y											
516	5Q	249935	2177781	19.67961	-155.38523	1788	1/14/2013	Saddle	Metrosideros	volcanicus															
601	4Q	630169	2356129	21.30236	-157.74505	360	2/15/2012	Hawaiiloa	mixed																
602	4Q	630374	2357616	21.31578	-157.74296	488	2/15/2012	Hawaiiloa	Santalum					y											
603	4Q	613209	2371624	21.44347	-157.90750	456	2/18/2012	Manana	Santalum	mana	y			y											H. mana collected in October; Lasioglossum also on Scaevola
604	4Q	613846	2372020	21.44701	-157.90132	555	2/18/2012	Manana	Metrosideros																
605	4Q	637055	2357060	21.31026	-157.67860	286	2/19/2012	Kamehame	mixed																
606	4Q	638905	2355123	21.29262	-157.66093	coast	2/19/2012	Kaiwi	Myoporum									y							
607	4Q	639032	2355163	21.29297	-157.65970	coast	2/19/2012	Kaiwi	Heliotropium									y				y			
608	4Q	639096	2355253	21.29378	-157.65907	coast	2/19/2012	Kaiwi	Heliotropium	anthracinus															
609	4Q	616384	2367731	21.40811	-157.87712	496	2/20/2012	Aiea	Santalum																
610	4Q	616429	2367748	21.40825	-157.87669	502	3/31/2012	Aiea	Santalum	mana															Hylaeus collected in July
611	4Q	596069	2355455	21.29840	-158.07380	coast	2/21/2012	Barbers Point	Heliotropium					y	y			y							
612	4Q	620616	2380279	21.52118	-157.83541	coast	4/1/2012	Kam Hwy	Heliotropium																
613	4Q	615241	2386979	21.58205	-157.88683	coast	4/1/2012	Kam Hwy	Heliotropium																
614	4Q	575118	2385965	21.57503	-158.27441	coast	4/2/2012	Kaena	Sesbania, diverse	longiceps								y							Lasioglossum at Jacquemontia
615	4Q	574700	2385951	21.57492	-158.27845	coast	4/2/2012	Kaena	Sesbania																
616	4Q	609194	2381178	21.53003	-157.94562	549	4/3/2012	Poamoho	Metrosideros					y											
617	4Q	610471	2381364	21.53163	-157.93327	637	4/3/2012	Poamoho	Metrosideros	unicus															
618	4Q	590748	2380048	21.52085	-158.12378	573	4/4/2012	Manuwai	Metrosideros		y														
619	4Q	590647	2379934	21.51983	-158.12475	597	4/4/2012	Manuwai	Metrosideros																
620	4Q	590590	2380006	21.52048	-158.12530	583	4/4/2012	Manuwai	Dodonaea				y	y											
621	4Q	590750	2380108	21.52139	-158.12375	566	4/4/2012	Manuwai		makaha															Hylaeus makaha caught sweeping, not on flower
622	4Q	590705	2379816	21.51875	-158.12420	643	4/4/2012	Manuwai	Metrosideros																
623	4Q	590673	2379734	21.51802	-158.12452	681	4/4/2012	Manuwai	Santalum																
624	4Q	590658	2379696	21.51768	-158.12466	693	4/4/2012	Manuwai	Santalum																
625	4Q	608071	2378656	21.50732	-157.95662	532	4/5/2012	Waikane	Acacia	connectens															
626	4Q	608148	2378666	21.50740	-157.95587	534	4/5/2012	Waikane	Hedyotis	connectens															
627	4Q	583633	2382053	21.53931	-158.19236	682	5/16/2012	Pahole	Bidens	connectens	y		y											Ochetellus glaber	Hylaeus collected in May, Lasio in July
628	4Q	583749	2381573	21.53497	-158.19128	718	5/16/2012	Pahole	Metrosideros		y			y											
629	4Q	593076	2374015	21.46623	-158.10164	773	5/17/2012	Hapapa	Acacia	unicus				y											
630	4Q	592863	2374056	21.46661	-158.10369	891	5/17/2012	Hapapa	Metrosideros	unicus				y											
631	4Q	592808	2374183	21.46776	-158.10421	890	5/17/2012	Hapapa	Metrosideros	unicus				y											

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
632	4Q	592979	2374076	21.46679	-158.10256	816	5/17/2012	Hapapa	Pisonia		y														
633	4Q	628724	2357958	21.31898	-157.75883	530	5/18/2012	Wiliwilinui	Metrosideros	unicus				y											unicus collected July only; trap nests set out in hollow of horizontal koa branch on west side of trail
634	4Q	587534	2377999	21.50250	-158.15491	883	5/19/2012	Waianae	Metrosideros	unicus	y			y											unicus collected July only
635	4Q	587727	2377986	21.50237	-158.15305	970	5/19/2012	Waianae	Metrosideros	unicus				y											
636	4Q	587902	2377996	21.50246	-158.15136	1016	5/19/2012	Waianae	Cheirodendron																trap nests set out on north side of trail on far side of ohia
637	4Q	582283	2386746	21.58177	-158.20518	coast	5/20/2012	Mokuleia	Heliotropium									y				y			Hylaeus strenuus; first record outside of Honolulu
638	4Q	575172	2385869	21.57416	-158.27389	coast	5/20/2012	Kaena	Myoporum								y								
639	4Q	575101	2385855	21.57404	-158.27458	coast	5/20/2012	Kaena	Myoporum														y		Pheidole at other places in Kaena
640	4Q	575128	2385969	21.57507	-158.27432	coast	5/20/2012	Kaena	Sesbania											y					trap nests set out near rat station; Megtim collected 29 Jul
641	4Q	611377	2381600	21.53370	-157.92451	741	5/21/2012	Poamoho	Cheirodendron																trap nests placed above trail (climb up streambed just mauka)
642	4Q	611652	2382221	21.53930	-157.92181	811	5/21/2012	Poamoho	Cheirodendron	unicus															
643	4Q	590590	2378349	21.50551	-158.12539	705	6/27/2012	Schofield	Santalum		y													Technomyrmex albipes	
644	4Q	590186	2378660	21.50834	-158.12928	806	6/27/2012	Schofield	Metrosideros		y														
645	4Q	612347	2371178	21.43950	-157.91584	416	6/28/2012	Manana	Metrosideros		y														
646	4Q	637759	2354378	21.28598	-157.67203	coast	6/28/2012	Kaiwi	Scaevola			y		y											
647	4Q	638945	2355141	21.29278	-157.66054	coast	6/28/2012	Kaiwi	Scaevola	anthracinus															
648	4Q	639156	2355387	21.29499	-157.65848	coast	6/28/2012	Kaiwi	Scaevola			y													
649	4Q	586084	2380441	21.52464	-158.16878	662	6/29/2012	Kaala	Metrosideros	unicus	y														
650	4Q	588527	2379311	21.51430	-158.14526	1070	6/29/2012	Kaala	Cheirodendron																
651	4Q	588523	2379338	21.51455	-158.14530	1071	6/29/2012	Kaala	Cheirodendron																
652	4Q	575069	2385929	21.57471	-158.27489	coast	6/29/2012	Kaena	Myoporum			y			y										
653	4Q	630150	2353509	21.27870	-157.74543	coast	6/30/2012	Maunalua	Scaevola																
654	4Q	637910	2354391	21.28608	-157.67057	coast	6/30/2012	Kaiwi	Scaevola			y		y				y							
655	4Q	637932	2354396	21.28613	-157.67036	coast	6/30/2012	Kaiwi	Scaevola	anthracinus															
656	4Q	637965	2354407	21.28623	-157.67004	coast	6/30/2012	Kaiwi	Heliotropium	anthracinus															nesting in retaining wall made of coral rock
657	4Q	638138	2354624	21.28817	-157.66836	coast	6/30/2012	Kaiwi	Heliotropium			y										y			
658	4Q	638786	2357566	21.31470	-157.66187	coast	6/30/2012	Makapuu	Santalum					y						y					
659	4Q	638790	2357595	21.31496	-157.66183	coast	6/30/2012	Makapuu	Heliotropium			y		y				y							
660	4Q	580550	2383059	21.54854	-158.22209	525	7/1/2012	Kaluakauila	Metrosideros												y		y	Ochetellus glaber	
661	4Q	580595	2383557	21.55303	-158.22164	590	7/1/2012	Kaluakauila	Metrosideros		y	y	y										y		
662	4Q	587358	2377876	21.50140	-158.15662	772	7/26/2012	Waianae	Euphorbia	makaha, connectens															
663	4Q	628904	2358296	21.32202	-157.75708	585	7/27/2012	Wiliwilinui	Scaevola					y											
664	4Q	628912	2358330	21.32233	-157.75700	591	7/27/2012	Wiliwilinui	Metrosideros					y											
665	4Q	583618	2386811	21.58230	-158.19228	coast	7/28/2012	Mokuleia	mixed					y				y				y			
666	4Q	582387	2386715	21.58149	-158.20417	coast	7/28/2012	Mokuleia	mixed				y	y				y				y			Lasioglossum collected in pan trap only
667	4Q	583448	2382481	21.54318	-158.19413	650	7/28/2012	Pahole	Bidens				y												
668	4Q	583648	2381969	21.53855	-158.19223	692	7/28/2012	Pahole	ground	laetus			y												
669	4Q	578400	2383186	21.54978	-158.24285	coast	7/29/2012	Kaena south	Scaevola					y											
670	4Q	616601	2367797	21.40868	-157.87503	540	7/30/2012	Aiea	Psychotria	mana															
671	4Q	580688	2378003	21.50286	-158.22100	101	8/28/2012	Keaau	Erythrina													y		Ochetellus glaber	
672	4Q	580827	2377921	21.50211	-158.21966	128	8/28/2012	Keaau	Erythrina													y			
673	4Q	580849	2377858	21.50154	-158.21946	175	8/28/2012	Keaau	Erythrina													y			
674	4Q	576930	2386104	21.57621	-158.25691	15	8/29/2012	Kaena	Euphorbia	connectens													y	Ochetellus glaber	east of Alau
675	4Q	575404	2385983	21.57518	-158.27165	coast	8/29/2012	Kaena	Euphorbia																
676	4Q	575136	2385893	21.57438	-158.27425	coast	8/29/2012	Kaena	Euphorbia			y	y												
677	4Q	593378	2371238	21.44112	-158.09888	968	8/30/2012	Puu Kaua	Metrosideros																
678	4Q	622795	2355662	21.29866	-157.81616	37	8/31/2012	Manoa	Erythrina													y			Erythrina crista-galli
679	4Q	581897	2385852	21.57371	-158.20895	117	8/31/2012	Kealia	Sapindus																
680	4Q	581856	2385855	21.57374	-158.20934	125	8/31/2012	Kealia	Erythrina													y			
681	4Q	581751	2385878	21.57395	-158.21035	135	8/31/2012	Kealia	Myoporum		y	y													
682	4Q	581772	2385753	21.57282	-158.21016	228	8/31/2012	Kealia	Erythrina													y		Plagiolepis, Ochetellus	
683	4Q	594550	2390787	21.61767	-158.08646	coast	8/31/2012	Sunset Beach	Heliotropium					y	y								y		also Scaevola
684	4Q	629270	2357781	21.31735	-157.75359	511	9/1/2012	Wailupe	Metrosideros					y											
685	4Q	629272	2357798	21.31750	-157.75357	511	9/1/2012	Wailupe	Santalum																
686	4Q	629280	2357808	21.31759	-157.75349	513	9/1/2012	Wailupe	Scaevola																
687	4Q	629469	2357148	21.31161	-157.75171	410	9/1/2012	Wailupe	Euphorbia																
688	4Q	636976	2354302	21.28535	-157.67958	112	9/2/2012	Koko Crater	Solanaceae?		y		y												
689	4Q	636956	2354301	21.28534	-157.67978	110	9/2/2012	Koko Crater	Erythrina													y			Megachile gentilis
690	4Q	636904	2354246	21.28486	-157.68028	113	9/2/2012	Koko Crater	Euphorbia		y														
691	4Q	636760	2354276	21.28513	-157.68167	118	9/2/2012	Koko Crater	Erythrina													y			
692	4Q	636743	2354273	21.28511	-157.68183	123	9/2/2012	Koko Crater	Hibiscus				y												

Name	Zone	Easting	Northing	Lat	Long	Elev (m)	Date	Site	Plant	Hylaeus (Nesoprosopis)	Lasio impavidum	Lasio microlepoides	Lasio sp tegulare grp	Apis	Xylocopa	Ceratina arizonensis	Ceratina dentipes	Ceratina smaragdula	Meg umbripennis	Meg timberlakei	Hylaeus albonitens	Hylaeus strenuus	Anoplolepis	other ants	notes
693	4Q	636733	2354287	21.28524	-157.68193	120	9/2/2012	Koko Crater	Myoporum			y										y			
694	4Q	636960	2354841	21.29023	-157.67969	83	9/2/2012	Koko Crater	Scaevola					y											
695	4Q	608225	2389424	21.60458	-157.95443	560	9/3/2012	Laie	Metrosideros	unicus															
696	4Q	608098	2389202	21.60258	-157.95567	607	9/3/2012	Laie	Metrosideros																
697	4Q	595040	2355456	21.29847	-158.08373	coast	9/5/2012	Kalaeloa	Myoporum			y													
698	4Q	594781	2355343	21.29745	-158.08623	coast	9/5/2012	Kalaeloa	Myoporum			y													
699	4Q	594774	2355581	21.29960	-158.08628	coast	9/5/2012	Kalaeloa	Capparis			y													
700	4Q	608682	2381307	21.53123	-157.95055	570	10/4/2012	Poamoho	Metrosideros	unicus															
701	4Q	609598	2381146	21.52971	-157.94172	556	10/4/2012	Poamoho	Scaevola	unicus															
702	4Q	611479	2381671	21.53434	-157.92352	759	10/5/2012	Poamoho	Scaevola	unicus															
703	4Q	611833	2381009	21.52834	-157.92014	788	10/6/2012	Poamoho	Cheirodendron	unicus				y											
704	4Q	611948	2380821	21.52663	-157.91905	789	10/6/2012	Poamoho	Syzygium	unicus															
705	4Q	629278	2356536	21.30610	-157.75361	233	10/7/2012	Wailupe	Passiflora				y											Ochetellus glaber	
706	4Q	629307	2356706	21.30763	-157.75331	283	10/7/2012	Wailupe	Euphorbia								y								
707	4Q	612868	2371459	21.44201	-157.91080	470	10/9/2012	Manana	Psychotria		y														
708	4Q	613767	2371912	21.44604	-157.90210	522	10/9/2012	Manana	Metrosideros	unicus	y														
709	4Q	590615	2380214	21.52236	-158.12505	583	10/10/2012	Manuwai	Metrosideros	connectens	y														
710	4Q	611709	2392197	21.62941	-157.92060	coast	10/29/2012	Laie	Scaevola				y									y		Ochetellus, Technomyrmex	Hylaeus strenuus on Heliotropium
711	4Q	610919	2395299	21.65749	-157.92802	coast	10/29/2012	Malaekahana	Heliotropium	anthracinus												y			anthracinus rare
712	4Q	610963	2395458	21.65891	-157.92759	coast	10/29/2012	Malaekahana	Heliotropium	anthracinus															
713	4Q	610971	2395577	21.65999	-157.92750	coast	10/29/2012	Malaekahana	Heliotropium	anthracinus												y			strenuus rare
714	4Q	610985	2395663	21.66077	-157.92736	coast	10/29/2012	Malaekahana	Scaevola	anthracinus															
715	4Q	621194	2361846	21.35462	-157.83115	521	10/30/2012	Lanihuli	Scaevola	unicus															
716	4Q	621452	2362076	21.35669	-157.82865	582	11/3/2012	Lanihuli	Scaevola	mimicus, unicus				y											
717	4Q	587493	2378002	21.50253	-158.15531	881	11/2/2012	Waianae	Acacia	unicus	y														
718	4Q	585894	2380061	21.52121	-158.17064	765	11/4/2012	Kaala	Metrosideros	unicus				y											
719	4Q	586255	2379614	21.51715	-158.16718	819	11/4/2012	Kaala	Metrosideros	unicus				y							y				unicus in morning, albonitens in afternoon
720	4Q	588576	2378467	21.50668	-158.14483	1221	11/4/2012	Kaala	Metrosideros	unicus															
721	4Q	626859	2356740	21.30811	-157.77691	409	11/5/2012	Mauumae	Scaevola		y														
722	4Q	626987	2357019	21.31062	-157.77566	455	11/5/2012	Mauumae	Scaevola		y													Ochetellus glaber	
723	4Q	627071	2357018	21.31060	-157.77485	466	11/5/2012	Mauumae	Santalum	mana	y		y	y											
724	4Q	627464	2357775	21.31742	-157.77100	510	11/5/2012	Mauumae	Santalum								y								Ceratina caught on Mimosa
725	4Q	635446	2352989	21.27361	-157.69443	58	12/22/2012	Hanauma Bay	Scaevola																
726	4Q	635473	2352985	21.27357	-157.69418	54	12/22/2012	Hanauma Bay	Heliotropium									y				y			
727	4Q	635126	2352496	21.26918	-157.69756	coast	12/22/2012	Hanauma Bay	Heliotropium					y								y			
728	4Q	612583	2368220	21.41276	-157.91376	375	1/19/2013	Halapepenui	Metrosideros																
729	4Q	613041	2368491	21.41519	-157.90933	413	1/19/2013	Halapepenui	Metrosideros					y								y		Technomyrmex alates	
730	4Q	613253	2369193	21.42151	-157.90724	441	1/19/2013	Halapepenui	Santalum																
731	4Q	613576	2369377	21.42315	-157.90411	450	1/19/2013	Halapepenui	Santalum																
732	4Q	616335	2363331	21.36836	-157.87791	284	1/20/2013	Tripler	Metrosideros					y								y		Pheidole megacephala	
733	4Q	618908	2364622	21.37985	-157.85300	489	1/20/2013	Tripler	Scaevola	mana															
734	4Q	619413	2364786	21.38130	-157.84812	498	1/20/2013	Tripler	Scaevola	mamo															
735	4Q	586620	2377968	21.50226	-158.16373	820	1/22/2013	Waianae	Acacia	anomalus															
736	4Q	605093	2401059	21.70987	-157.98395	coast	3/30/2013	Kahuku	Heliotropium	anthracinus								y							
737	4Q	605171	2401078	21.71004	-157.9832	coast	3/30/2013	Kahuku	Euphorbia	anthracinus								y							
738	4Q	605396	2401015	21.70946	-157.98103	coast	3/30/2013	Kahuku	Sesbania	longiceps															
739	4Q	605455	2401027	21.70956	-157.98045	coast	3/30/2013	Kahuku	Heliotropium	longiceps															
740	4Q	605875	2400988	21.70918	-157.9764	coast	3/30/2013	Kahuku	Heliotropium	anthracinus								y							
741	4Q	606242	2401037	21.70961	-157.97285	coast	3/30/2013	Kahuku	ground	anthracinus															