



**Results of the 2007-2008 Alien Arthropod
Species and Wēkiu Bug Monitoring
on Mauna Kea, Hawai'i Island**

**Hawaii
Biological
Survey**

Final Report

December 2009

**RESULTS OF THE 2007–2008 ALIEN SPECIES AND WĒKIU BUG (*NYSIUS WEKIUCOLA*)
SURVEYS ON THE SUMMIT OF MAUNA KEA, HAWAI'I ISLAND**

FINAL REPORT

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EXECUTIVE SUMMARY

As part of a continuing long-term study, the Hawaii Biological Survey of the Bishop Museum was contracted by the Office of Mauna Kea Management (OMKM) to monitor for alien arthropod species and to continue monitoring populations of the wēkiu bug (*Nysius wekiuicola* Ashlock & Gagné), which is endemic to the Mauna Kea summit area. Ten day field trips were conducted in June 2007 and July 2008 to provide a baseline of introduced arthropod species found at the Mauna Kea summit, and to continue monitoring wēkiu bug populations within critical core habitats. Forty-seven data loggers that were placed at the summit in 2006 to monitor soil temperatures and relative humidities were removed in July 2008. Data were successfully downloaded from 24 operating loggers that provided new information related to wēkiu bug soil temperature preferences.

The objective of the alien arthropod baseline and monitoring surveys was to provide information to managers on any potential threats to endemic Mauna Kea arthropod species such as the wēkiu bug. Intensive surveys for ants were conducted to assess if any populations are currently found within any areas in close proximity to wēkiu bugs. Ants are already well-established at the summit regions of Haleakalā National Park, and this elevational range is well-within that of lowest elevation that wēkiu bugs have been found. Because of the predatory and social nature of ants, and because ants have caused the extinction and decline of native arthropods throughout Hawai‘i, it was imperative to search high risk areas around the Mauna Kea summit region. This included public roadways, picnic areas, and around buildings. During the course of this study we did not see or collect any ants at the summit region, and in fact obtained the highest wēkiu bug captures since the 1997–1998 field season during trapping in the 2007 field season. Of concern was the finding of several predatory species of alien beetles, with the major new finding of a predatory carabid beetle that so far appears to be restricted to just around the Lake Waiau shoreline area.

Data downloaded from temperature loggers was analyzed using the GIS ArcMap Inverse Distance Weighted model that predicted mean yearly soil surface temperatures. The upper regions of all slopes on Pu‘u Hau Oki and the north slope of Pu‘u Hau Kea were predicted to have the coldest annual temperatures of less than 5° C, and these two areas also generally have the highest wēkiu bug captures at the summit. The warmest region was found to be the Lake Waiau area, where wēkiu bugs have not been captured during the past ten years of study.

INTRODUCTION

As part of a continuing long-term study, the Hawaii Biological Survey of the Bishop Museum was contracted for the 2007–2008 field seasons by the Office of Mauna Kea Management (OMKM) to assess and document alien arthropod species found at the Mauna Kea summit area. The purpose of these field studies was to establish a baseline for possible alien arthropod species currently inhabiting the Mauna Kea summit area having the potential to negatively affect wēkiu bugs (*Nysius wekiuicola* Ashlock & Gagné) or other native arthropod species. Additionally, to provide long-term capture data in areas of known critical wēkiu bug habitat, wēkiu bug population monitoring also occurred during the 2007–2008 field seasons at the Mauna Kea summit area.

This study continues Bishop Museum's wēkiu bug research that originated in the early 1980s (Howarth and Stone 1982), and resumed again in the late 1990s to the present (Howarth et al. 1999, Englund et al. 2002, 2005, 2007, Porter and Englund 2006). OMKM was interested in obtaining baseline data for alien arthropod species having the potential to threaten wēkiu bugs and other native arthropods. The objectives for the 2007–2008 field seasons were to 1) conduct surveys for alien arthropod species in areas of known wēkiu bug core habitat at the Mauna Kea summit area, and adjacent but less favored habitats, 2) assess alien arthropod species composition at the summit areas on Mauna Kea with high tourist and worker activities, including observatory areas, the Hale Pohaku visitor center, and roadways, 3) conduct a baseline survey for alien arthropod species in areas around the proposed Thirty Meter Telescope (TMT), and the batch plant staging area that will be used if the TMT is built, and 4) monitor wēkiu bug populations in selected known high quality habitats to provide comparisons to previous Bishop Museum surveys.

STUDY AREA

The overall study area for the 2007–2008 field season has been thoroughly described in previous Bishop Museum reports and this can be found in Howarth et al. (1982), Howarth et al. (1999), Englund et al. (2002, 2005, 2007) and Porter and Englund (2006). The study area started at the Hale Pohaku visitor center and staff quarters at 2,850 m (9,300 ft) elevation, and encompassed portions of the alpine zone of the Mauna Kea volcano (Figure 1), including both the Mauna Kea Science Reserve (MKSR) and the Mauna Kea Ice Age Natural Area Reserve (NAR). For the purposes of this study, we defined cinder cones as non-vegetated, dormant volcanic cones in the alpine zone above 2,925 m, (9,600 ft). Elevations sampled for alien arthropods during 2007–2008 fieldwork ranged from a maximum of 4,205 m (13,796 ft) at the summit of Pu'u Wēkiu to a low of 2,850 m (9,300 ft) around Hale Pohaku. Visual observations were also made throughout the study area while hiking between sampling points. Tables 1–4 contain GPS coordinates, elevations, and date traps were set for all sample points within the study area. Because the present study was for both wēkiu bugs and alien arthropod species, all species (except wēkiu bugs) collected in traps during these studies were kept for further analysis. This is also why some of the sample locations are duplicated for the alien species and wēkiu bug data tables (i.e., Tables 1 and 2). Sample locations were duplicated in Tables 1-4 when non-wēkiu bug taxa were collected in wēkiu bug pitfall traps.

Unless otherwise stated, pu‘u names were derived from USGS topographic quad maps. WGS 84 datum was used for recording GPS locations. Many pu‘u have not yet been given official names, and when possible these cinder cones are identified by their altitude as stated on USGS topo maps. However, when no altitudes are given names of nearby landmarks or distinctive features were used. These names should not be viewed as official, but rather allow us to more easily identify specific areas of the vast summit region of Mauna Kea. Altitudes were determined using a combination of USGS 7.5 minute topographic quad maps, a handheld altimeter, and a barometric altimeter on the GPS unit, calibrated daily at Hale Pohaku and at the elevation markers on the road up to the observatories.

METHODS

Alien Arthropod Species

The objectives for the 2007–2008 fieldwork season changed from previous years, and sampling emphasized documenting alien species found within the Mauna Kea summit area. An analysis of all arthropod species collected during the 2007–2008 field trips was conducted for the present study. Species were identified to the lowest possible taxonomic unit possible, which was dependent upon expertise available for each taxonomic group.

The main purpose of fieldwork of the present study was to establish the current baseline for alien species and identify species on Mauna Kea having the potential to negatively affect wēkiu bugs and other native arthropods. In this regard we sampled a broad range of habitats at the summit, focusing on various pathways whereby alien arthropods might first become introduced. We also sampled a wide variety of undisturbed habitat types where wēkiu bugs are known to have high concentrations, and nearby disturbed habitats that are always in conjunction with past or present human activities.

A broad array of traps was used to collect alien arthropod species. Yellow pan traps and yellow sticky traps were used to collect flying insect species while glycol pitfall traps were used to collect non-flying arthropods. Yellow pan traps were ballasted with rocks to ensure they did not blow away in the windy summit area, and a small amount of ethylene glycol (antifreeze) was added to the water in each pan trap to prevent the water from freezing and reduce evaporation during the daytime. Yellow sticky traps were tied to large rocks that allowed both ground dwelling and flying arthropods access to these traps. Glycol pitfall traps were constructed similar to previous years wēkiu bug traps (Englund et al. 2002), baited with shrimp paste around the caprock, and filled with a mixture of water and glycol. Glycol pitfall traps were not placed in habitats likely to contain wēkiu bugs.

Because alien ant species are believed to rank as one of the highest threats to wēkiu bugs, particular effort was focused on determining the presence or absence of ant species within the Mauna Kea summit area. We heavily sampled for ants at visitor center picnic and garbage can areas, around Hale Pohaku staff areas, the summit lunch room building, and around several of the larger telescope facilities such as the Gemini and Keck observatories.

Ant traps consisted of wooden tongue depressor sticks dipped in generous amounts of peanut butter. All ant bait peanut butter traps were checked at regular intervals of at least every 2-3 days during the duration of the fieldwork. Numerous baited (with shrimp paste) glycol pitfall traps throughout the study area also served as potential ant traps.

In summary, the alien arthropod trapping at each collection locality had four different trap types: 1) peanut butter sticks for ants, 2) yellow sticky traps, 3) yellow pan traps, and 4) one ethylene glycol pitfall trap. These four different traps were all placed within about 4-5 m of each other, and a gps point was taken for that locality. These four traps in proximity ran for at least 3 days, and if needed were checked on a more regular basis to ensure liquid levels were adequate to capture arthropods. Tables 1 and 3 contain the collection localities for the alien arthropod traps set in 2007–2008.

Wēkiu Bug Sampling

In contrast to previous years sampling (Englund et al. 2002, 2005, 2007) no glycol pitfall traps were used in areas known or suspected to contain wēkiu bugs. During the 2007–2008 fieldwork, wēkiu bug sampling consisted of using baited shrimp pitfall traps (which generally do not harm the insects) in areas of known high wēkiu bug concentration. Limited visual surveys for wēkiu bugs were also conducted, but this met with limited success because there was no snowpack (in both 2007 and 2008) which tends to concentrate the bugs along the edges of the snow. A detailed explanation of techniques used for shrimp pitfall traps in this study can be found in Englund et al. (2002). Individual pitfall trap locations were recorded with GPS (WGS 84 datum), as were locations where wēkiu bugs were visually observed while hiking. Locations, elevations, cinder cone area, and length of time sampled can be found in Table 2 for the 2007 sampling and Table 4 for the 2008 sampling.

Temperature/Relative Humidity Probes

To obtain wēkiu bug microhabitat data in a wide variety of favorable and nearby suboptimal habitats (e.g., glaciated regions between cinder cones) 47 HOBO[®] Pro RH/Temp (Model H08-032-08) temperature probes were first placed near the surface and buried 10 in (25 cm) into the substrate in 2006, and removed in July 2008 (Table 10). Loggers were placed in a wide variety of other locations, in areas known to support high wēkiu bug densities, as well as areas where the bugs have not normally been captured (Figure 3).

The loggers recorded and stored relative humidity and temperature data for the duration of the study. It was necessary to provide a housing for the loggers to protect against contracting, expanding, and shifting substrates in the harsh environment of the Mauna Kea summit area. Following tests of various protective cases during the preceding study, PVC pipe caps with ventilation holes drilled in them were deemed to have the best protective qualities (Englund et al. 2005). The PVC cap fit snugly around the loggers, and was connected with stainless steel wire to protect the humidity sensor and prevent direct ground contact. Holes drilled in the cap also allowed drainage of any rainwater or snowmelt and provided air circulation. In areas of known wēkiu bug habitat (such as the summit of Pu‘u Hau Kea or Pu‘u Lilinoe) the loggers were placed in the exact locality where individual wēkiu bugs had been observed or collected.

The first major logger installation was in December 2004, with paired loggers were placed just below the surface and covered with local substrate, and also buried approximately 10 in (25 cm) below the surface. Loggers were connected by approximately 1 m of stainless steel wire (also with flagging tape attached) to make future retrieval easier, as finding loggers was quite difficult because of their small size and shifting substrates on steep, high elevation slopes.

In 2006, A total of 9 pairs of loggers (18 total) were placed in a transect at Pu‘u Hau Kea running through the summit cone area (see Englund *et al.* 2007 for a detailed map), starting at the bottom of the northwest rim and extending in a southeasterly direction into the cinder cone and down the slope to the bottom of the Pu‘u Hau Kea cinder cone. These loggers recorded conditions within the Pu‘u Hau Kea crater and outermost slopes, an area with some of the highest known wēkiu bug densities on Mauna Kea. Each logger pair consisted of one placed on the surface and one buried in the surface substrate to approximately 10-12 in (25-30 cm). All 47 loggers were recovered in July 2008.

High Incidence of Logger Failure

The HOBO[®] Pro RH/Temp (Model H08-032-08) temperature probes have been problematic throughout the course of the study and exhibited a high failure rate. Of the original 47 loggers installed in 2006, data were recovered from only 24 of all loggers, with the subsurface loggers having a much higher failure rate with data recovered from only 4 loggers. Although data collected from the loggers appears accurate and sound, these particular data logger models are apparently failure-prone and have since been discontinued by the manufacturer. Enough data were recovered to allow us to run the statistical temperature models (see below) for the surface temperatures at the Mauna Kea summit in both the favored and suboptimal wēkiu bug habitats. However, not enough data were available from the subsurface loggers to adequately run the computer model for the subsurface temperatures.

Statistical Analysis for Temperature/Relative Humidity Data

After temperature data were downloaded from the loggers to an excel spreadsheet, data were summarized and graphs and statistics were done with Sigma Plot version 10. Two years of data from the loggers were then summarized and combined by using Inverse Distance Weighted (IDW) models in ArcMap 9.2 (ESRI 1992-2006). These models used a simple predictive multivariate interpolation method to estimate values at unmeasured locations using known information. Multiple measured locations with variables of interest are used to predict those same variables in unmeasured locations with use of a smoothing operation. The method assumes that with distance the influence of a measured location decreases. User modification inputs are minimal and include the minimum and maximum number of known measured locations used to predict unmeasured areas (thus fixing the radius at which the surface is interpolated) and the power at which each point can influence the others. The power of each point influences the smoothness of the prediction area and can be optimized within analysis using the power optimization utility. The IDW output interprets a predictive surface using all available points (Yang 2007; Darsow 2009). The IDW output for temperature and relative humidity for all working

loggers with data downloaded in July 2008 is shown in Figures 5 (soil surface temperature predictions) and Figure 6 (soil surface relative humidity predictions) for the Mauna Kea summit area. An insufficient logger sample size precluded the use of the IDW model for subsurface soil temperatures.

For all IDW models at least 15 locations were used to predict and interpret the surface output and fix the radius of the calculation. The power of each point was optimized within ArcView (9.2) using the "optimize power output" function in the Geostatistical Analyst Extension in ArcMap (9.2) (ESRI 1992-2006) (Yang 2007).

The surface temperature (°C) and relative humidity (%) graphs (Figures 9–32) are indicative of slight but potentially important microclimate structure between areas. While thousands of data points were collected by the operating loggers throughout the two-year data collection period, we summarized the data by providing yearly and monthly averages for each data logger. Figures 11–32 provide a summary of the monthly average of temperature and relative humidity for each logger that was operating when they were removed in July 2008. Figures 9 and 10 display the entire two-year temperature average for each operating subsurface (Figure 9) and surface logger (Figure 10).



Hobo data loggers used to measure temperature and relative humidities at the Mauna Kea summit.

RESULTS AND DISCUSSION

The study period at the Mauna Kea summit for alien arthropod and wēkiu bug sampling ran from May 31– June 10, 2007, and in 2008 from July 19–27. Tables 1–4 summarize trap locations by cinder cone, elevation, date set, trap type, and GPS coordinates. Overall 2007 wēkiu bug sample effort was a total of 42 shrimp pitfall and 45 alien arthropod species traps. In 2008, 30 wēkiu bug traps and 225 separate alien species traps were set. Sample effort for wēkiu bugs was defined by total trap days, which are the number of nights each baited shrimp pitfall trap was operating. Shrimp pitfall trap effort for wēkiu bugs during the 2007 field season was 252 trap days, and 120 trap days in 2008 (see Tables 7 and 8).

Wēkiu Bug Trap Placements in Study Area

A total of 73 shrimp pitfall traps, were set in various cinder cone areas at selected elevations during fieldwork in 2007–2008 field season (Tables 2, 4, 7, 8). Sampled areas from 2007–2008 included the main summit region, with permanent monitoring stations at Pu‘u Hau Kea, Pu‘u Wēkiu, Pu‘u Hau Oki, and the Pu‘u’s north and south of the VLBA (Figures 1 and 2). No wēkiu bugs were collected in any of the 225 alien arthropod traps set out during the 2007–2008 field season.

Wēkiu Bug Collections

A record 537 wēkiu bugs were collected in early June 2007 (Table 7) during a total of 252 trap days. Sampling occurred slightly later in the summer of 2008, and 70 bugs were captured with an effort of 120 trap days in late July, during a time of year that appears to have somewhat lower wēkiu bug activity. Wēkiu bug collection data from the Pu‘u Hau Kea since 2001 was summarized in Table 9.

The Inverse Weighted Distance (IDW) model for wēkiu bug populations was conducted by using the 2007 Bishop Museum data only (with the 2008 Bishop Museum wēkiu data inputted as a correction factor) is shown in Figure 4. This model interpolates wēkiu bug densities using the ArcMap data inputted into a GIS map, and we used the 2007 data for the model because it was the peak year for wēkiu bug captures over the past 10 years of monitoring. The darkest areas on the map in Figure 4 indicated where the highest predicted populations of wēkiu bugs would be found, and the highest predicted core populations according to the model were found around Pu‘u Wēkiu to Pu‘u Kea and ranging to the north slopes of Pu‘u Hau Kea.

Temperature RH/Loggers

Cinder cone areas where data loggers were installed and downloaded are found in Table 10. Data were downloaded from the loggers in July 2008, and data were recovered from only 51% of the loggers (24 of 47). The location of surface and subsurface loggers with recoverable data are shown in Figure 3. Twenty of the operating loggers were placed at the surface and covered by only a thin layer of rocks, while only four of the loggers buried 0.3 m in the substrate had recoverable data. Downloaded data provided a unique wēkiu bug level representation of mainly surface temperatures and ground humidities over a broad range of optimal and sub optimal habitats.

To construct the ArcMap IDW model, data were inputted from the 2006–2008 surface loggers for temperatures and relative humidities throughout the Mauna Kea summit area. The predicted mean yearly soil surface temperatures are shown in Figure 5, with the darker shading indicating warmer temperatures. The Lake Waiau region was the warmest, with average predicted temperatures ranging between 7.45–7.75 °C, while Pu‘u Hau Oki and the north slope of Pu‘u Hau Kea were predicted to have the coldest annual temperatures of less than 5° C (Figure 5). It is of great interest that the two coldest predicted areas in Figure 5 also generally have the highest wēkiu bug captures at the summit as well. During the course of the Bishop Museum studies from 1998 to the present, wēkiu bugs have never been captured in the Lake Waiau region, or on the outer slopes of Pu‘u Waiau, which was modeled as the warmest region in the upper summit area. The modeling for relative humidity data shown in Figure 6 require further examination, but show the Lake Waiau region also had the highest humidities along with the highest modeled temperatures. The Pu‘u Waiau region was formed by a subglacially erupted hawaiite flow, implying this area has a much different geology than nearby cinder cones such as Pu‘u Hau Kea that stood as nunataks during Pleistocene glacial periods (Porter and Englund 2006).

Data were downloaded in July 2008 for each operating surface and subsurface logger and then graphically summarized into yearly and monthly averages (Figures 7–30). These logger data indicated a wide variation in soil surface temperatures throughout the summit, but that in some areas average monthly temperatures at or below freezing existed from December through April such as Figure 18 (Lake Waiau), Figures 17 and 23 (Poi Bowl), Figure 30 (Pu‘u Hau Oki), with little variance during these months. The low temperature variance during these months likely reflects the loggers being completely buried by snow.

Alien Arthropod Species Surveys

A wide range of native and non-native arthropod species were collected during the 2007–2008 field seasons, and a list of these species and sampling sites they were collected from is found in Appendix C. Sampling sites in Tables 1 and 3 correspond to the sites listed in Appendix A. Although many of the same taxa were found repeatedly at a large number of sample sites, we have also listed taxa found by collection area, as shown in the next section of the report.

Many of the arthropod species collected were classified as aeolian, or taxa that were carried with the wind or flew up from lower elevations. Because night-time temperatures go below freezing throughout most of the year, virtually all of the aeolian species have a short life span at the summit and are not considered residents. Resident species are either native species adapted to the harsh life conditions at the summit, or are non-native species from temperate regions that are able to withstand the daily freeze–thaw cycle and live and reproduce within the summit region. In general there should be less concern about aeolian, non-resident arthropod species that get blown up to the summit because they soon die and become a potential food source for wēkiu bugs.

For the alien arthropod species, the majority of the aeolian drift was represented by the species that were the stronger fliers, for example muscid and calliphorid flies, and lady beetles (*Hippodamia convergens* and *Coccinella septempunctata*). Although this was a presence/absence survey for alien arthropods, it was obvious from looking at the snowpack drift and our trap results that Diptera (primarily muscids) and lady beetles constituted the primary biomass of aeolian drift. Although diet preference studies for wēkiu bugs have not yet been published, we have made field observations of wēkiu bugs adjacent to snowpacks feeding on freshly thawed Diptera.

Hymenoptera were represented mostly by weaker flying taxa, with the exception of *Apanteles* spp. (a parasitoid) that were present in large numbers at the summit and common at all sites. The abundance of *Apanteles* spp. may be due to them being found at higher elevations (1500–2700 m). The European earwig (*Forficula forficularia*) was found in high numbers only around the Onizuka Visitor Center at Hale Pohaku, and is a pest and predatory, but has not become established above the visitor center. Psylliids were also extremely abundant (100 or more in most samples) in all areas up to the summit, but are aeolian drift from lower elevations. In a qualitative sense, aeolian drift species composition around the higher summit areas appears to be fairly consistent since the late 1990s.

Summary of Alien Arthropod Species Collected in 2007

The following is a summary of arthropods collected in discrete sampling areas during the 2007 field season, including a brief description of sample location along with any arthropod by-catch found during wēkiu bug collections. Detailed gps locations and further information for these sampling sites can be found in Tables 1-4 in the appendices section. Aeolian species found during these surveys are likely not a major threat to native species at this time, and it is likely that resident alien arthropod species have greater potential impacts.

To allow more information to be displayed, we have abbreviated standard entomological terms in the tables. Often it was difficult to determine the status of a particular species, that is why many have question marks next to their habitat and their end/adv (native/introduced) status. The following abbreviations in the 2007 species tables are based upon Nishida (2002):

end = endemic: native to the Hawaiian islands, and found only in Hawai‘i

adv = adventive: introduced into Hawai‘i, most likely accidentally introduced

pur = purposeful introduction: introduced into Hawai‘i usually for biological control of insect pests

Aeolian = species is not a resident of the area where it was collected, but blown up from lower elevations

Resident = lives and reproduces in the area where the species was collected

Below is a list of species found at specific sampling sites for the 2007 sampling field season, and a brief description of the sample area. Areas or sample sites with no insect collections are not included in the list below.

Hale Pohaku parking lot area: Located near the Hale Pohaku living quarters and cafeteria, this area was located at an elevation of approximately 2850 m. In 2007, there were no alien species of concern found around this area, although the parking lot and adjacent living area around Hale Pohaku has greater potential for new alien invertebrates than any other area with the exception of the Onizuka Visitor center. Native species of note were a healthy population of native *Hyaleus* sp. bees, along with a native seed bug (Lygaeidae). Alien ant species were not collected in this area (or anywhere at the Mauna Kea summit area at or above Hale Pohaku) in 2007.

HP Parking Lot (lower) (Sites 1, 4, 8, 13, 44, 45, 50)

order	family	genus-species-author	end/adv	habitat
Diptera	Ceratopogonidae	<i>Forcipomyia</i> sp.	end	Aeolian
Diptera	Drosophilidae	<i>Drosophila</i> sp.	adv	Aeolian
Diptera	Ephydriidae	<i>Hydrellia tritici</i> Coquillett	adv	Aeolian
Diptera	Ephydriidae	sp. 1	adv ?	Aeolian
Diptera	Muscidae	<i>Atherigona orientalis</i> Schiner	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp. 1	end ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Diptera	Tachinidae	<i>Phasioormia pallida</i> Townsend	adv	Aeolian
Heteroptera	Lygaeidae	<i>Geocoris pallens</i> Stal	adv	Resident
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 2 = phytophagus	end	Aeolian
Homoptera	Aphididae	<i>Aphis</i> sp.	adv	Aeolian
Hymenoptera	Apidae	<i>Apis mellifera</i> Linnaeus	adv	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp. 1	pur ?	Aeolian ?
Hymenoptera	Colletidae	<i>Hyleaus</i> sp. spp.	end	Aeolian
Hymenoptera	Vespidae	<i>Polistes olivacius</i>	adv	Aeolian
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Lepidoptera	Oecophoridae	<i>Agonopterix ulicetella</i>	pur	Aeolian

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Onizuka Visitor Center:

Although intensively sampled in 2007 with four series of four different kinds of insect traps, only aeolian introduced insect species were collected here, and none deemed to be potentially threatening to native taxa. Of interest, the native *Hyaleus* sp. bees were also common here in 2007. Sampling took place around the parking lot and around the trash cans at the visitor center, with ants not being found in 2007.

Onizuka Visitor Center (Sites 5, 10, 47, 49)

order	family	genus-species-author	end/adv	habitat
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Ephydriidae	<i>Hydrellia tritici</i> Coquillett	adv	Aeolian
Diptera	Muscidae	<i>Atherigona orientalis</i> Schiner	adv	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Hymenoptera	Apidae	<i>Apis mellifera</i> Linnaeus	adv	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp. 1	pur ?	Aeolian ?
Hymenoptera	Colletidae	<i>Hyaleus</i> sp. spp.	end	Aeolian
Hymenoptera	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson	adv	Aeolian
Lepidoptera	Oecophoridae	<i>Agonopterix ulicetella</i>	pur	Aeolian

VLBA Parking Lot

Only two species were found in the region around the VLBA parking lot (3725 m elevation) and none are resident species capable of causing harm to native arthropod species.

VLBA Parking Lot Area (Sites 28, 36)

order	family	genus-species-author	end/adv	habitat
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian

Batch Plant Parking Lot (trailhead area to Lake Waiiau): The batch plant parking lot is a large, flat, graded area at approximately 4040–4070 m elevation, adjacent to the base of Pu‘u Hau Kea. This area is also the parking lot for visitor day hikes to Lake Waiiau. The only resident species found here was an endemic noctuid moth, and we did not find any potential harmful species here during the 2007 sampling.

Batch Plant Parking Lot (Sites 16, 19, 30, 38, 48)

order	family	genus-species-author	end/adv	habitat
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Ephydriidae	<i>Hydrellia tritici</i> Coquillett	adv	Aeolian
Diptera	Muscidae	<i>Atherigona orientalis</i> Schiner	adv	Aeolian
Diptera	Muscidae	indet	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Hymenoptera	Ichneumonidae	<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp. 1	pur ?	Aeolian ?
Lepidoptera	Noctuidae	<i>Agrotis</i> sp.	end	Resident

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Pu'u Hau Kea:

This cinder cone was part of the annual wēkiu bug monitoring during the 2007 field season, and collections of alien arthropod species here were resulted from bycatch found in wēkiu bug shrimp traps. No potential harmful arthropod species were collected here in 2007.

Puu Hau Kea (Sites 3, 46)

order	family	genus-species-author	end/adv	habitat
Diptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Hymenoptera	Ichneumonidae	?Genus ?species	adv ?	Aeolian
Thysanoptera	Thripidae	<i>Thrips</i>	end ?	Aeolian

Lower Hau Kea Parking Lot Area: This small parking lot is located near the 13,000 ft sign on the summit road. Two endemic species were collected here, and neither of the introduced insect species here pose a threat to natives.

Lower Hau Kea Parking Lot by 13,000 ft sign (Site 37)

order	family	genus-species-author	end/adv	habitat
Araneae	Lycosidae	<i>Lycosa</i> sp.	end	Resident
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian

Lake Waiau: This area included the shoreline, grassy areas, muddy areas near shore, the intermittent stream outflow of Lake Waiau, and the nearshore waters. The waters of Lake Waiau serve as a deadly attraction to aeolian insects as none of the alien (adv/pur) species shown below likely will withstand the near-daily freezing temperatures at the 4000 m elevation. In 2007 there were no potentially harmful resident alien species collected at Lake Waiau.

Lake Waiau (Sites 2, 6, 7, 9, 12, 14, 15, 17, 18, 24, 26, 31, 35)

order	family	genus-species-author	end/adv	habitat
Acari	Undet	Undet	end ?	Resident ?
Araneae	Lycosidae	<i>Lycosa</i> sp.	end	Resident
Araneae	Linyphiidae	more than 1 species	end/adv ?	Resident
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Dytiscidae	<i>Rhantus pacificus</i>	end	Resident
Coleoptera	Hydrophilidae	?Genus ?species	pur ?	Aeolian
Coleoptera	Staphylinidae	several species	end ?	Aeolian
Collembola	Entomobryidae	more than one species	end ?	Resident ?
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Ceratopogonidae	<i>Forcipomyia</i> sp.	end	Aeolian
Diptera	Chironomidae	undetermined	end ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Muscidae	<i>Atherigona orientalis</i> Schiner	adv	Aeolian
Diptera	Muscidae	undetermined	adv ?	Aeolian
Diptera	Phoridae	several spp.	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Sphaeroceridae	<i>Copromyza equina</i> (Fallen)	adv	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Heteroptera	Lygaeidae	<i>Geocoris pallens</i> Stal	adv	Resident
Heteroptera	Lygaeidae	<i>Neacoryphus bicrucis</i> Say	adv	Aeolian
Homoptera	Cicadellidae	?Genus ?species	adv ?	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Apidae	<i>Apis mellifera</i> Linnaeus	adv	Aeolian
Hymenoptera	Braconidae	<i>Bracon</i> sp. 1	pur ?	Aeolian ?
Hymenoptera	Braconidae	<i>Apanteles</i> sp. 1	pur ?	Aeolian ?
Hymenoptera	Ichneumonidae	<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian
Hymenoptera	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson	adv	Aeolian
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian

Pu'u Wēkiu: Although we did not specifically set traps for alien arthropod species here and only used shrimp traps for wēkiu bugs at Pu'u Wēkiu, the bycatch in the traps was collected, with several likely introduced species of *Leptocera* flies found here in the cinder cone.

Pu'u Wekiu (Sites 20, 23, 29)

order	family	genus-species-author	end/adv	habitat
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian

Pu'u Hau Oki: The uppermost slopes of this cinder cone contain the Keck and Subaru Observatories, and the area sampled here includes insect traps around the Keck Observatory, and the list below also includes bycatch from wēkiu bug traps placed throughout the cinder cone. The only resident arthropod species collected here (other than wēkiu bugs) was the large lycosid spiders. All other arthropod taxa collected here in 2007 were aeolian species unlikely to survive overnight.

Pu'u Hau Oki (Sites 22, 27)

order	family	genus-species-author	end/adv	habitat
Diptera	Phoridae	several spp.	adv ?	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp. 1	end ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Araneae	Lycosidae	<i>Lycosa</i> sp.	end	Resident

Summit Lunchroom: The area sampled here included inside and around the summit lunchroom building at 4226 m elevation. Insect traps were placed around the building, inside the building on trash cans, and in the long underground hallway area. Even though this area has food and high traffic, no alien arthropod species of concerns were found here, and the summit lunchroom building is apparently too cold for even cockroaches to survive.

Summit lunch room area (Sites 21, 41, 42)

order	family	genus-species-author	end/adv	habitat
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diiptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Diiptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian

Gemini Telescope: The Gemini telescope observatory building area was sampled with a variety of insect traps within a 0–5 m distance of the observatory buildings. Arthropod species collected here in 2007 were entirely

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aeolian and not considered residents or species that would reproduce in this area. Of interest was the collection of an endemic *Hyleaus* sp. bee that was blown up from lower elevations.

Gemini Telescope (Sites 25, 32, 34)

order	family	genus-species-author	end/adv	habitat
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Muscidae	<i>Atherigona orientalis</i> Schiner	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Apidae	<i>Apis mellifera</i> Linnaeus	adv	Aeolian
Hymenoptera	Ichneumonidae	<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Muscidae	<i>Atherigona orientalis</i> Schiner	adv	Aeolian
Diptera	Muscidae	indet	adv ?	Aeolian
Diptera	Phoridae	several spp.	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Apidae	<i>Apis mellifera</i> Linnaeus	adv	Aeolian
Hymenoptera	Colletidae	<i>Hyleaus</i> sp. spp.	end	Aeolian

Summary of Alien Arthropod Species Collected in 2008

The following is a summary of arthropods collected in discrete sampling areas during the 2008 field season, including a brief description of sample location along with any arthropod by-catch found during wēkiu bug collections. Detailed gps locations and further information for these sampling sites can be found in Tables 1-4. Aeolian species found during these surveys are likely not a major threat to native species at this time, and it is likely that resident alien arthropod species have far greater potential impacts.

To allow more information to be displayed, we have abbreviated standard entomological terms in the tables. Often it was difficult to determine the status of a particular species, that is why many have question marks next to their habitat and their end/adv (native/introduced) status. The following abbreviations in the 2008 species tables are based upon Nishida (2002):

end = endemic: native to the Hawaiian islands, and found only in Hawai‘i

adv = adventive: introduced into Hawai‘i, most likely accidentally introduced

pur = purposeful introduction: introduced into Hawai‘i usually for biological control of insect pests

Aeolian = species is not a resident of the area where it was collected, but blown up from lower elevations

Resident = lives and reproduces in the area where the species was collected

Below is a list of species found at specific sampling sites for the 2008 sampling field season, and a brief description of the sample area. Areas or sample sites with no insect collections are not included in the list below.

Hale Pohaku parking lot near old water tanks: This area is located at the old redwood water tanks adjacent to the original stone buildings for former state park, in the employees parking lot.

HP Parking lot near old water tanks (Sites 70-73)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Staphylinidae	<i>Creophilus maxillosus</i> (Linnaeus)		Resident
Dermaptera	Forficulidae	<i>Forficula forficularia</i>	adv	Resident
Diptera	Ephydriidae	Genus (?) species (?)	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	undetermined	adv ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Heteroptera	Lygaeidae	<i>Geocoris pallens</i> Stal	adv	Resident
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Apidae	<i>Apis mellifera</i> Linnaeus	adv	Aeolian
Hymenoptera	Colletidae	<i>Hyleaus</i> sp. spp.	end	Aeolian
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Hymenoptera	Sphecidae	Genus (?) species (?)	adv ?	Aeolian
Thysanoptera	Thripidae	several species	end ?	Aeolian

All but three species collected here appeared to be aeolian (wind-blown) species from lower elevations. The introduced European earwig (*Forficula forficularia*) has the potential to be a pest species, but so far has not been collected above the Hale Pohaku region, and it is not known whether it can withstand the harsh conditions of the

summit. The hairy rove beetle (*Creophilus maxillosus*) was also found here, and is a likely introduction to Hawai'i and now widely found on many island areas and also throughout the northern Neotropical and Holarctic regions (Englund *et al.* 2005). The hairy rove beetle feeds on dead and decaying carcasses but also is a generalist predator, thus could be considered a potential threat to the wēkiu bug. In 2005 this species was found at the summit of Pu'u Pohaku (4020 m), thus its range encompasses the entire elevational range of the Mauna Kea summit region.

Hale Pohaku parking lot area: This area is located at the employees parking lot, on the opposite side of the old water tanks.

HP Parking lot (lower) (Sites 74-85)

order	family	genus-species-author	end/adv	habitat
Araneae	Gnaphosidae	<i>Urozeletes rusticus</i> (L. Koch)	adv	Resident
Araneae	Clubionidae	Genus (?) species (?)	end ?	Resident ?
Collembola	Entomobryidae	more than 1 species	end ?	Resident ?
Coleoptera	Carabidae	<i>Laemostenus complanatus</i> (Dejean)	adv	Aeolian
Dermaptera	Forficulidae	<i>Forficula forficularia</i>	adv	Resident
Diptera	Agromyzidae	undetermined	adv	Aeolian
Diptera	Muscidae	<i>Stomoxys calcitrans</i> (Linnaeus)	adv	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Diptera	Sphaeroceridae	Genus (?) species (?)	end ?	Resident ?
Diptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagous	end	Aeolian
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Hymenoptera	Colletidae	<i>Hyleaus</i> sp. spp.	end	Aeolian
Hymenoptera	Bethylidae	<i>Sterola</i> sp.	end	Resident
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Braconidae	<i>Bracon</i> sp. 1	pur ?	Aeolian ?
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Hymenoptera	Ichneumonidae	<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian
Hymenoptera	Ichneumonidae	?Genus ?species	adv ?	Aeolian
Hymenoptera	Sphecidae	<i>Ectemnius</i> sp.	end	Aeolian
Lepidoptera	Oecophoridae	<i>Agonopterix ulicetella</i>	pur	Aeolian
Lepidoptera	Pterophoridae	<i>Lantanophaga pusillidactyla</i> (Dyar)	pur	Aeolian
Psocoptera	Psocidae	?Genus ?species	adv ?	Resident ?
Thysanoptera	Thripidae	several species	end ?	Aeolian

Six possible or potential resident arthropod species were collected in the lower Hale Pohaku parking lot, including two spider (Araneae) species, one fly species, and another non-predatory psocid species. It is unknown what, if any, impacts the two introduced spider species could have. Similar to the nearby water tank sample area, earwigs were abundant here.

Onizuka Visitor Center: Sampling took place here in the same localities as in 2007, with the same types of insect traps. Areas sampled were around the parking lot, next to trash cans, and near the restrooms. The resident non-indigenous arthropod taxa found here are not likely to threaten wēkiu bugs at higher elevations, and in fact species such as earwigs (*Forficula*) are not found at the higher summit elevations.

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Onizuka Visitor Center (Sites 86-101)

order	family	genus-species-author	end/adv	habitat
Araneae	nr. Clubionidae	damaged - undetermined	adv	Resident ?
Collembola	Entomobryidae	more than 1 species	end ?	Resident ?
Coleoptera	Carabidae	<i>Laemostenus complanatus</i> (Dejean)	adv	Aeolian
Coleoptera	Staphylinidae	several spp. undetermined	end ?	Aeolian
Dermaptera	Forficulidae	<i>Forficula forficularia</i>	adv	Resident
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Ceratopogonidae	<i>Forcipomyia</i> sp.	end	Aeolian
Diptera	Ephydriidae	Genus (?) species (?)	adv ?	Aeolian
Diptera	Muscidae	<i>Haematobia irritans</i> (Linnaeus)	adv	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Devoidy)	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Diptera	Tephritidae	undetermined	adv ?	Resident ?
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Homoptera	Cicadellidae	?Genus ?species	adv ?	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian

Batch Plant Parking Lot (trailhead area to Lake Waiau): The batch plant parking lot is a large, flat graded area at approximately 4040–4070 m elevation, adjacent to the base of Pu‘u Hau Kea, and the area sampled here were the lower elevations of the graded batch plant area. This area is also the parking lot for visitor day hikes to Lake Waiau. The only resident alien species of concern to native insect taxa collected here was the hairy rove beetle (*Creophilus maxillosus*), which was also collected in the lower HP Parking lot [see earlier 2008 HP parking lot section for details]. The other aeolian arthropod species found here likely pose little threats to wēkiu bugs and other native arthropods.

Batch Plant (Sites 109-128)

order	family	genus-species-author	end/adv	habitat
Araneae	Lycosidae	<i>Lycosa</i> sp.	end	Resident
Collembola	Entomobryidae	more than 1 species	end ?	Resident ?
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Coleoptera	Staphylinidae	<i>Creophilus maxillosus</i> (Linnaeus)	adv	Resident
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Ephydriidae	Genus (?) species (?)	adv ?	Aeolian
Diptera	Muscidae	<i>Haematobia irritans</i> (Linnaeus)	adv	Aeolian
Diptera	Muscidae	<i>Stomoxys calcitrans</i> (Linnaeus)	adv	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sciaridae	?Genus ?species	adv ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy)	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Tachinidae	<i>Ormia ochracea</i> (Bigot)	adv	Aeolian
Diptera	undet.	undetermined	adv ?	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 2 = phytophagus	end	Aeolian
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Megachilidae	<i>Megachile timberlakei</i> Cockerell	adv	Aeolian
Lepidoptera	Oecophoridae	<i>Agonopterix ulicetella</i>	pur	Aeolian
Thysanoptera	Thripidae	several species	end ?	Aeolian

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Upper Batch Plant area (upper Pu‘u Hau Kea parking lot area): This area encompassed the upper elevation areas of the graded batch plant area adjacent to the trailhead to Lake Waiau. None of the resident alien arthropod species found here are considered a potential threat, and none of the native species would be considered threats to wēkiu bugs either. More taxonomic work needs to be done on the staphylinid beetles and clubionid spiders to determine their native or adventive (i.e., introduced) status.

Upper Puu Hau Kea Parking lot (Sites 129-147)

order	family	genus-species-author	end/adv	habitat
Araneae	Lynphiidae	more than 1 species	end/adv ?	Resident
Araneae	Lycosidae	<i>Lycosa</i> sp.	end	Resident
Araneae	Clubionidae	Genus (?) species (?)	end ?	Resident ?
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Coleoptera	Staphylinidae	several species	end ?	Aeolian
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Drosophilidae	<i>Drosophila</i> sp.	adv	Aeolian
Diptera	Muscidae	<i>Stomoxys calcitrans</i> (Linnaeus)	adv	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy)	adv	Aeolian
Diptera	Sepsidae	<i>Sepsis</i> sp.	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Sphaeroceridae	?Genus ?species	end ?	Resident ?
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Diptera	undet.	undetermined	adv ?	Aeolian
Heteroptera	Lygaeidae	<i>Geocoris pallens</i> Stal	adv	Resident
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Braconidae	<i>Bracon</i> sp. 1	pur ?	Aeolian ?
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Hymenoptera	Ichneumonidae	<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian
Hymenoptera	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson	adv	Aeolian
Hymenoptera	Ichneumonidae	?Genus ?species	adv ?	Aeolian
Thysanoptera	Thripidae	several species	end ?	Aeolian

Lake Waiau: This area included the shoreline, grassy areas, muddy areas near shore, the intermittent stream outflow of Lake Waiau, and the nearshore waters. The waters of Lake Waiau serve as a deadly attraction to aeolian insects as none of the alien (adv/pur) species shown below likely will withstand the near-daily freezing temperatures at the 4000 m elevation. In 2008 a potentially harmful resident alien carabid species, *Agonum muelleri*, was collected at Lake Waiau. Carabid beetles are predatory and thus have the potential to cause unforeseen long-term impacts to wēkiu bugs and other native summit arthropods.

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Lake Waiau (Sites 148-151)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Carabidae	<i>Agonum cf. muelleri</i> (Herbst)	adv	Resident ?
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Tachinidae	<i>Gonia longipulvilli</i> Tothill	adv	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 2 = phytophagus	end	Aeolian
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Hymenoptera	Ichneumonidae	<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian

VLBA Parking Lot: The area sampled here was near the parking lot of the VLBA facility at 3725 m elevation. Although a full series of insect traps was placed here in 2008, it is unknown why no native or introduced were collected here.

VLBA Parking Lot (Sites 166-169)

order	family	genus-species-author	end/adv	habitat
no specimens in traps				

Keck Observatory (back side): In 2008 sampling for alien arthropods occurred around the Keck building, mainly around the backside of the building (opposite of the parking lot). Because this area was very close to one of the major populations of wēkiu bugs in Pu‘u Hau Oki crater, care was taken to set traps in areas unlikely to attract wēkiu bugs. Although we caught wēkiu bugs in live shrimp pitfall traps only a few meters away in Pu‘u Hau Oki crater, none were captured during sampling around the Keck facility. The only resident species collected here was a possible native Diptera (fly) species, all other species here were aeolian arthropod taxa.

Keck Observatory - Back Side (Sites 155-157)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Drosophilidae	<i>Drosophila</i> sp.	adv	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy)	adv	Aeolian
Diptera	Sphaeroceridae	?Genus ?species	end ?	Resident ?
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	undet.	undetermined	adv ?	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Braconidae	?Genus ?species	adv	Aeolian

Summit Lunchroom: The area sampled here included inside and around the summit lunchroom building at 4226 m elevation. Insect traps were placed around the building, inside the building on trash cans, and in the long underground hallway area. Similar to 2007, this area had food and high traffic, yet no alien arthropod species of

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concerns were found here, and the summit lunchroom building is apparently too cold for even cockroaches to survive.

Summit Lunchroom (Sites 158-161)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Drosophilidae	<i>Drosophila</i> sp.	adv	Aeolian
Diptera	Ephydriidae	Genus (?) species (?)	adv ?	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sciaridae	<i>Sciara</i> sp.	adv ?	Aeolian
Diptera	Sciaridae	?Genus ?species	adv ?	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Sphaeroceridae	Genus (?) species (?)	end ?	Resident ?
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Heteroptera	Lygaeidae	<i>Geocoris pallens</i> Stal	adv	Resident
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Apidae	<i>Apis mellifera</i> Linnaeus	adv	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Lepidoptera	undet.	undetermined	adv ?	Aeolian
Thysanoptera	Thripidae	several species	end ?	Aeolian

Gemini Observatory: The Gemini telescope observatory building area was sampled with a variety of insect traps within a 0–5 m distance of the observatory buildings. All arthropod species collected here in 2008 were entirely aeolian and not considered residents or species that would reproduce in this area, and thus were likely to pose few future threats to native arthropods and wēkiu bugs.

Gemini Observatory (Sites 162-165)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Diptera	Ephydriidae	<i>Hydrellia tritici</i> Coquillett	adv	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy)	adv	Aeolian
Diptera	Sepsidae	<i>Sepsis</i> sp.	adv	Aeolian
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Homoptera	Cicadellidae	Genus (?) species (?)	adv ?	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson	adv	Aeolian
Thysanoptera	Thripidae	several species	end ?	Aeolian

Parking Lot by John Burns sign: This parking lot is located just of the paved portion of the summit road at 3634 m, and is near a large cinder cone that has been heavily sampled for wēkiu bugs for many years (with never a

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wēkiu capture), and also been monitored with temperature and humidity loggers (see logger section, this report). All insects collected here aeolian drift, and ants were not observed or collected here.

John Burns parking lot (Sites 178-181)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian

Proposed Thirty Meter Telescope area: This area is in the flats region where the Thirty Meter Telescope has been proposed to be built (exact trap locations can be found in Table 3). Wēkiu bugs have never been collected in this region because it lies in a heavily glaciated region (Englund et al. 2007). In 2008 a comprehensive arthropod survey was conducted, including glycol pitfall and other various insect traps. Only three resident species were collected here, the large native *Lycosa* spider, a native springtail (Collembola), and a potentially native species of fly. Threats from nonindigenous species to native taxa were not observed at this site.

Thirty Meter Telescope (Sites 170-177)

order	family	genus-species-author	end/adv	habitat
Araneae	Lycosidae	<i>Lycosa</i> sp.	end	Resident
Collembola	Entomobryidae	more than 1 species	end ?	Resident ?
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Coleoptera	Hydrophilidae	?Genus ?species	pur ?	Aeolian
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Drosophilidae	<i>Drosophila</i> sp.	adv	Aeolian
Diptera	Ephydriidae	<i>Hydrellia tritici</i> Coquillett	adv	Aeolian
Diptera	Muscidae	<i>Haematobia irritans</i> (Linnaeus)	adv	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sciaridae	<i>Sciara</i> sp.	adv ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy)	adv	Aeolian
Diptera	Sepsidae	<i>Sepsis</i> sp.	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Sphaeroceridae	Genus (?) species (?)	end ?	Resident ?
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Diptera	Syrphidae	<i>Eristalis tenax</i> (Linnaeus)	adv	Aeolian
Diptera	Tachinidae	?Genus ?species	adv	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 1 = phytophagus	end	Aeolian
Heteroptera	Lygaeidae	<i>Nysius</i> sp. 2 = phytophagus	end	Aeolian
Homoptera	Aphidae	Genus (?) species (?)	adv	Aeolian
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Hymenoptera	Ichneumonidae	<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian
Hymenoptera	Ichneumonidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Sphécidae	Genus (?) species (?)	adv ?	Aeolian

NASA Infrared Telescope Facility: A wide variety of insect traps were placed around the building here, with only two resident species captured here, a native fly and a native moth species. The remaining species collected here were aeolian drift with little, if any, potential harmful potential to native taxa.

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NASA Observatory (Sites 182-185)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Diptera	Calliphoridae	<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?
Diptera	Ephydriidae	<i>Hydrellia tritici</i> Coquillett	adv	Aeolian
Diptera	Muscoidea	undetermined	adv ?	Aeolian
Diptera	Phoridae	several species	adv ?	Aeolian
Diptera	Sarcophagidae	several spp.	adv	Aeolian
Diptera	Sciaridae	? <i>Bradysia</i> sp.	end ?	Aeolian
Diptera	Sphaeroceridae	Genus (?) species (?)	end ?	Resident ?
Diptera	Syrphidae	<i>Allograpta</i> sp.	pur	Aeolian
Homoptera	Cicadellidae	?Genus ?species	adv ?	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Undetermined	Undetermined micro-hymenoptera	adv.	Aeolian
Lepidoptera	Noctuidae	<i>Agrotis</i> sp.	end	Resident

Arthropod By-Catch from Wēkiu Traps: Arthropod by-catch (both native and introduced species) found in wēkiu bug shrimp pitfall traps during fieldwork are shown below.

Pu'u Hau Kea: Arthropod species were collected in wēkiu bug traps around the Hau Kea summit area, one of the prime habitats, however, no resident species with the potential to impact wēkiu bugs were found here.

Puu Hau Kea (Sites 186-205)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Coleoptera	Staphylinidae	several species	end ?	Aeolian
Diptera	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy)	adv	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?
Hymenoptera	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson	adv	Aeolian

VLBA Region: Bycatch in this area was found in traps in the pu'u immediately north of the VLBA facility. Resident nonindigenous were not found in shrimp pitfall traps at this site, but one endemic moth was collected.

VLBA North Puu (Sites 211-215)

order	family	genus-species-author	end/adv	habitat
Hymenoptera	Megachilidae	<i>Megachile timberlakei</i> Cockerell	adv	Aeolian
Lepidoptera	Noctuidae	<i>Agrotis</i> sp.	end	Resident

Pu'u Wēkiu: This region included the wēkiu traps in Pu'u Wēkiu area. No positively identified resident nonindigenous arthropod species were found in the shrimp pitfall traps here.

Puu Wekiu (Sites 216-220)

order	family	genus-species-author	end/adv	habitat
Aranaeae	Lynphiidae	more than 1 species	end/adv ?	Resident
Coleoptera	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian
Diptera	Sphaeroceridae	<i>Copromyza equina</i> (Fallen)	adv	Aeolian
Diptera	Sphaeroceridae	<i>Leptocera</i> (several species)	adv ?	Aeolian
Diptera	Sphaeroceridae	Genus (?) species (?)	end ?	Resident ?
Homoptera	Psyllidae	Genus (?) species (?)	adv ?	Aeolian
Hymenoptera	Braconidae	<i>Apanteles</i> sp.	pur ?	Aeolian ?

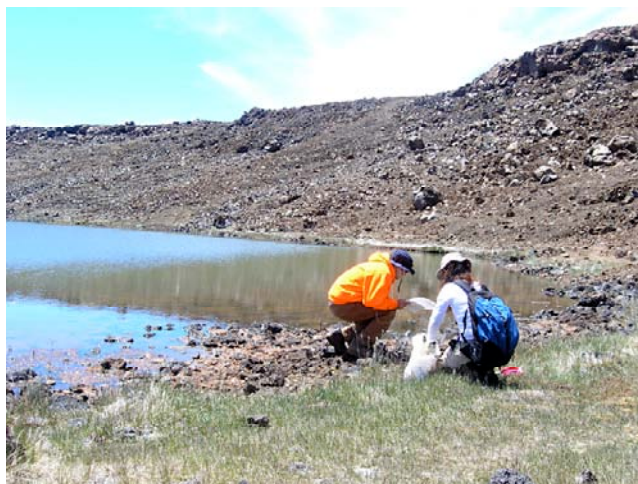
Pu'u Hau Oki: Only one extremely abundant species was found in traps here, the ubiquitous lady beetle (*Coccinella septempunctata*), a non-resident introduced aeolian species found everywhere at the summit in the summer months.

Puu Hau Oki (Sites 221-225)

order	family	genus-species-author	end/adv	habitat
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i> L.	pur	Aeolian

Introduced Species of Concern: Carabidae

In 2008 a new state record for an introduced species of predatory carabid beetle (*Agonum muelleri*) was established around Lake Waiau. Although it appears this species has been established for some time around Lake Waiau, no published or unpublished records were available to determine how long it has been established there. While *Agonum muelleri* appears to currently have a restricted range in the Lake Waiau region, which is not particularly favorable for wēkiu bugs, this predatory insect could compete for food and potentially prey upon native insect species in the summit area. This important finding underscores the need for regular monitoring of the Mauna Kea alpine environment for alien predatory insects. Since 2005 several new alien predatory species that could adversely impact the wēkiu bug have been found, including other beetles such as dermestids (1 new Hawai‘i Island record) and staphylinids (2 new state records) (see Englund *et al.* 2005).



Sampling the Lake Waiau shoreline.

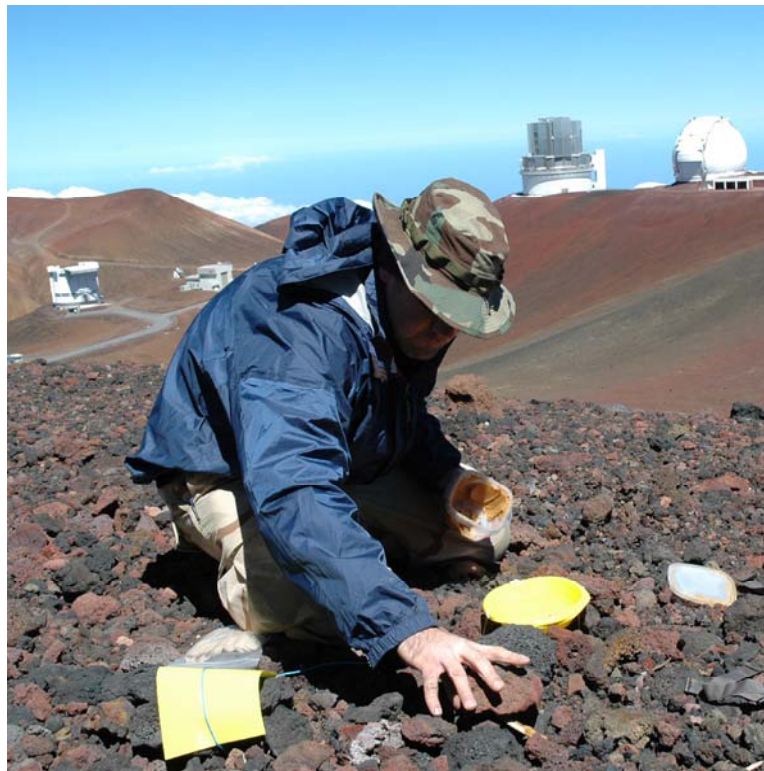
Other Potential Threats to Wēkiu Bugs

Alien ant species are the greatest potential threat to wēkiu bugs at the Mauna Kea summit area. Argentine ants (*Linepithema humile*) are currently found at Haleakalā National Park, Maui in elevational ranges close to overlapping with that of the lower distribution of wēkiu bugs (Krushelnycky *et al.* 2005). At Haleakalā National Park ant invasions have been documented to decrease native arthropod species diversity, with native predators such as the large endemic wolf spider (*Lycosa* sp.) rapidly declining in the face of ant invasions (Krushelnycky and Gillespie 2008). An endemic wolf spider (*Lycosa* sp.) is also found at Mauna Kea and is one of the top predators of the summit region, and along with the wēkiu bug would be expected to precipitously decline if ants ever become established. Because wēkiu bugs are much more restricted in their habitat choice than the wide ranging native wolf spiders (generally the bugs are found in the upper 20-30% of non-glaciated cinder cones), it is expected that wēkiu bugs would be even more vulnerable to ant invasions than the spiders. No new species of alien spiders were found during the 2007–2008 fieldwork that could potentially cause impacts to wēkiu bugs.

Regular monitoring and a rapid response to any ant introduction in the summit area, or along roadways going to the summit will be necessary to ensure the continued survival of the wēkiu bug. The European earwig mentioned above is predatory and a scavenger, and thus also has the potential to interact negatively with wēkiu bugs. Earwigs have never been found above the Hale Pohaku area and apparently are unable to handle the harsher summit conditions.

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Alien species sampling, yellow pan, peanut butter, and sticky traps.

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APPENDIX A: FIGURES

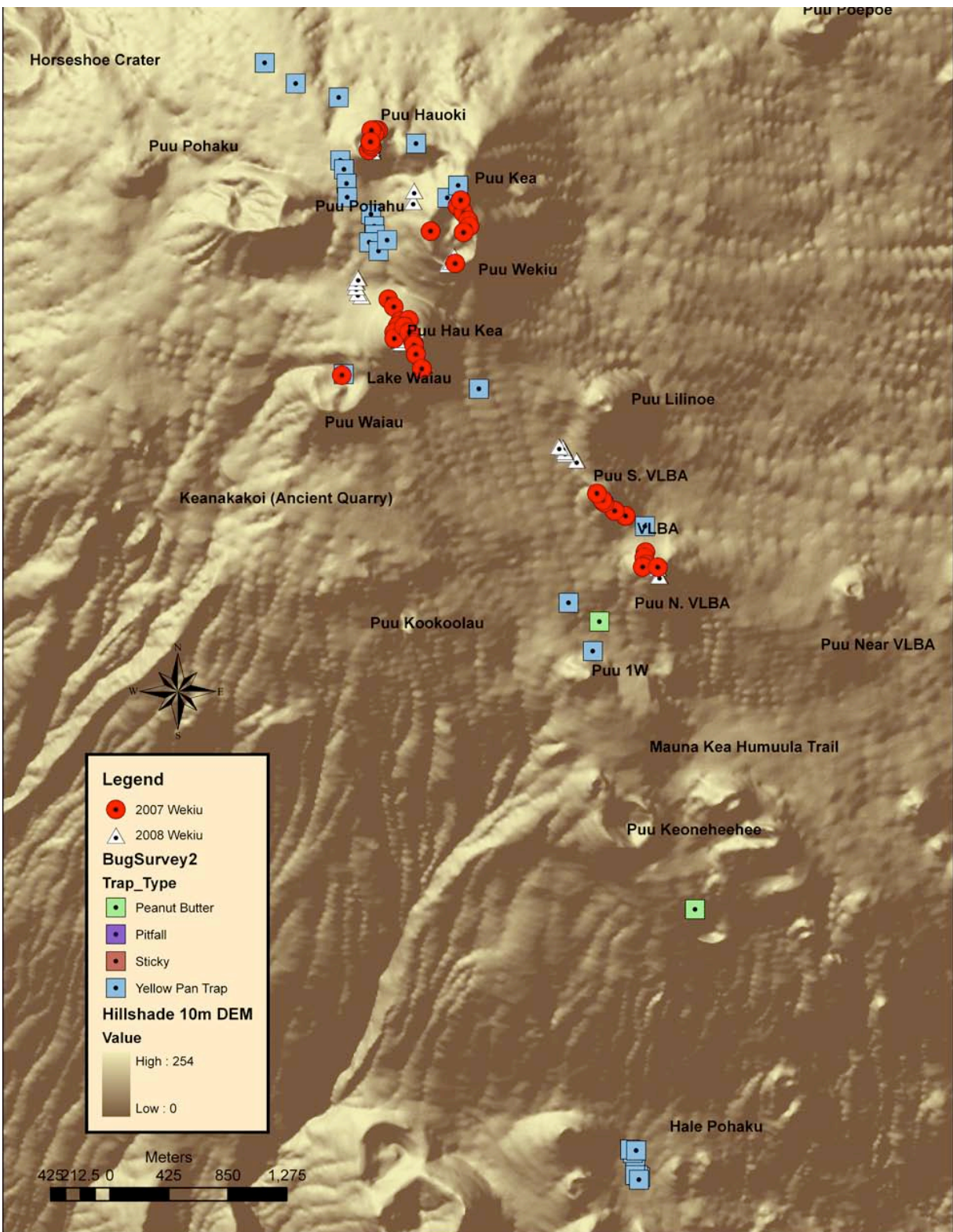


Figure 1. Overall study area for 2007–2008 fieldwork for the alien arthropod species and wēkiu bug sampling.

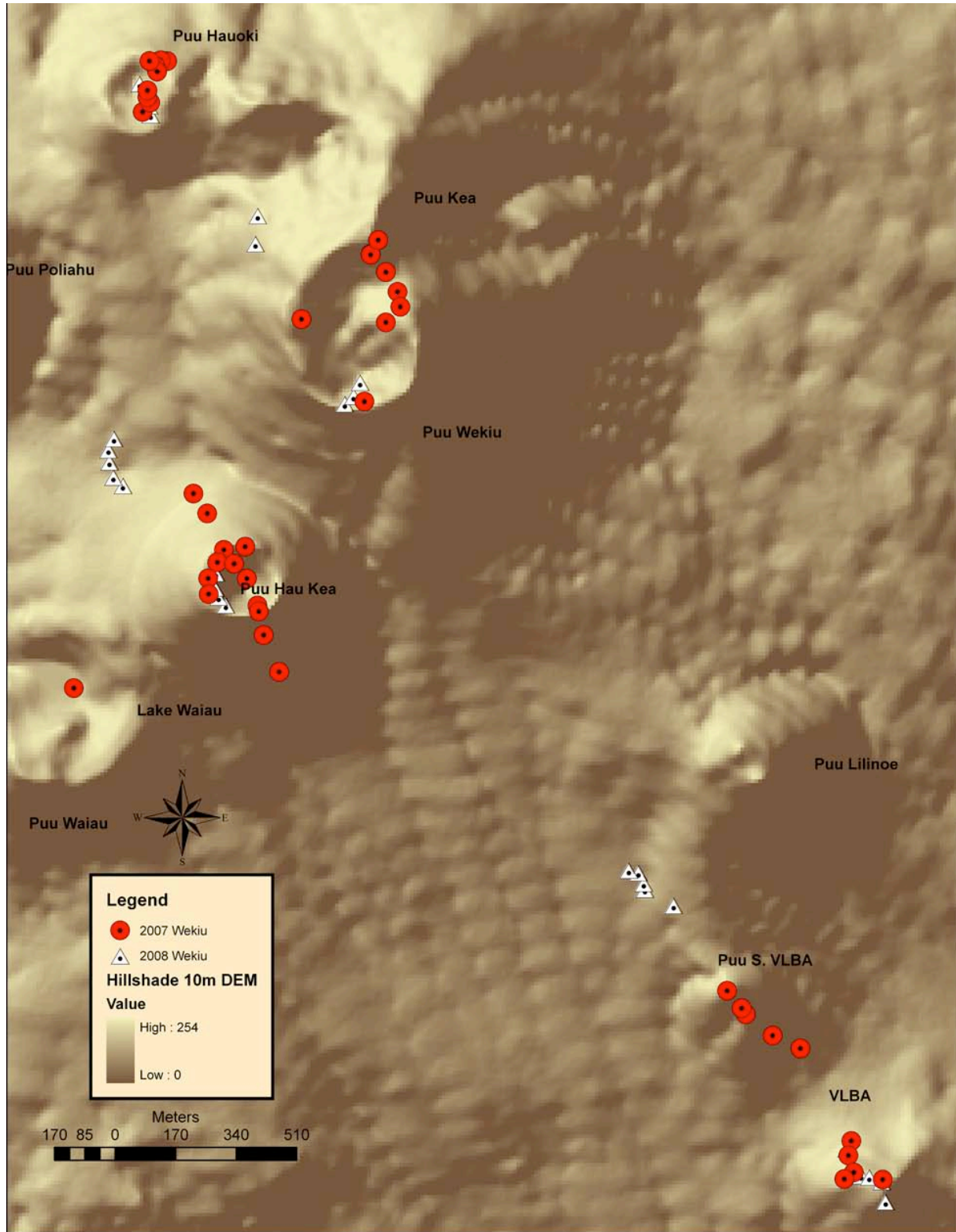


Figure 2. Overall study area for wēkiu bug sampling sites during the 2007 and 2008 field seasons.

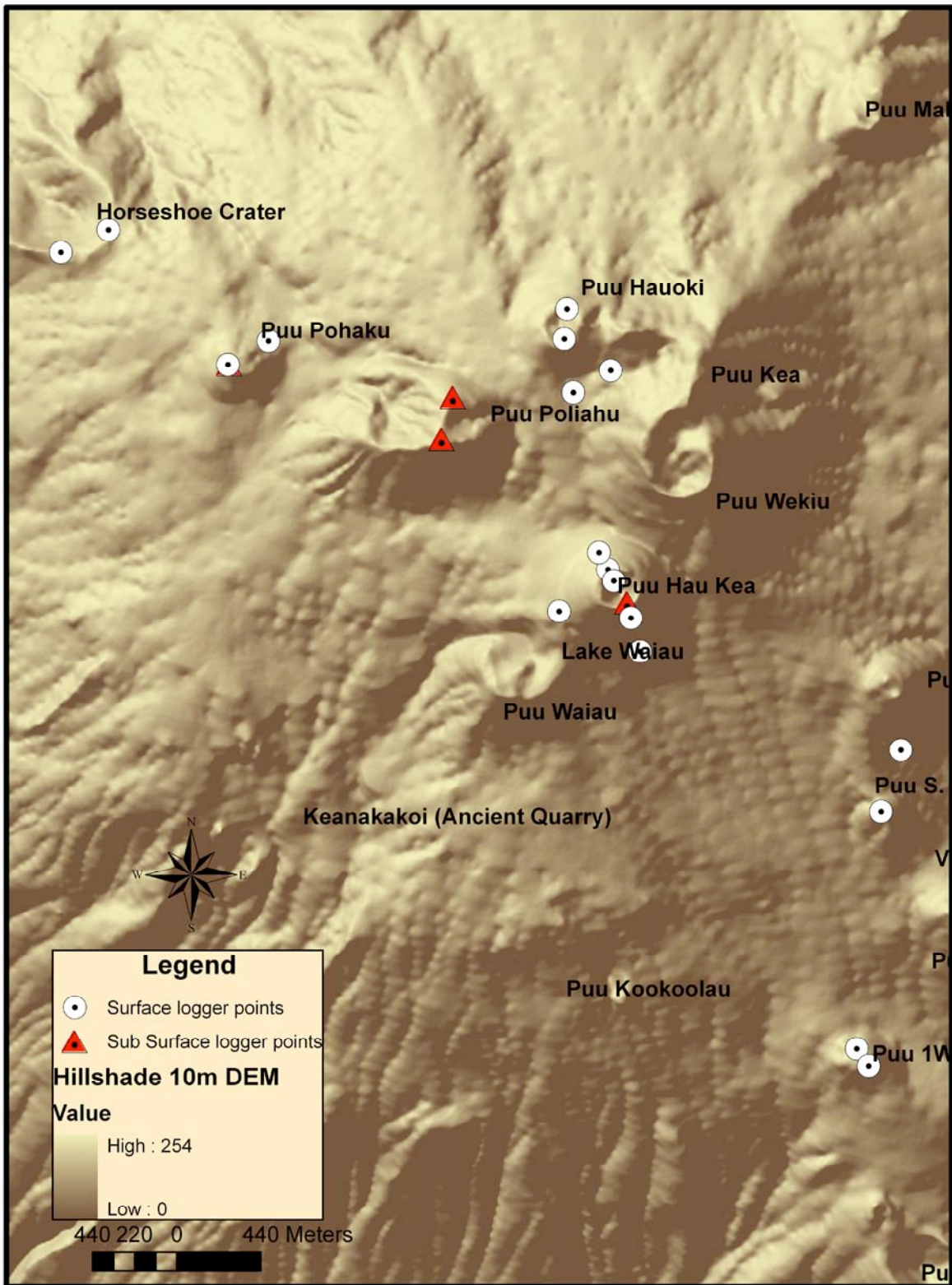


Figure 3. Operating temperature/relative humidity data loggers from the summit of Mauna Kea pulled in July 2008.

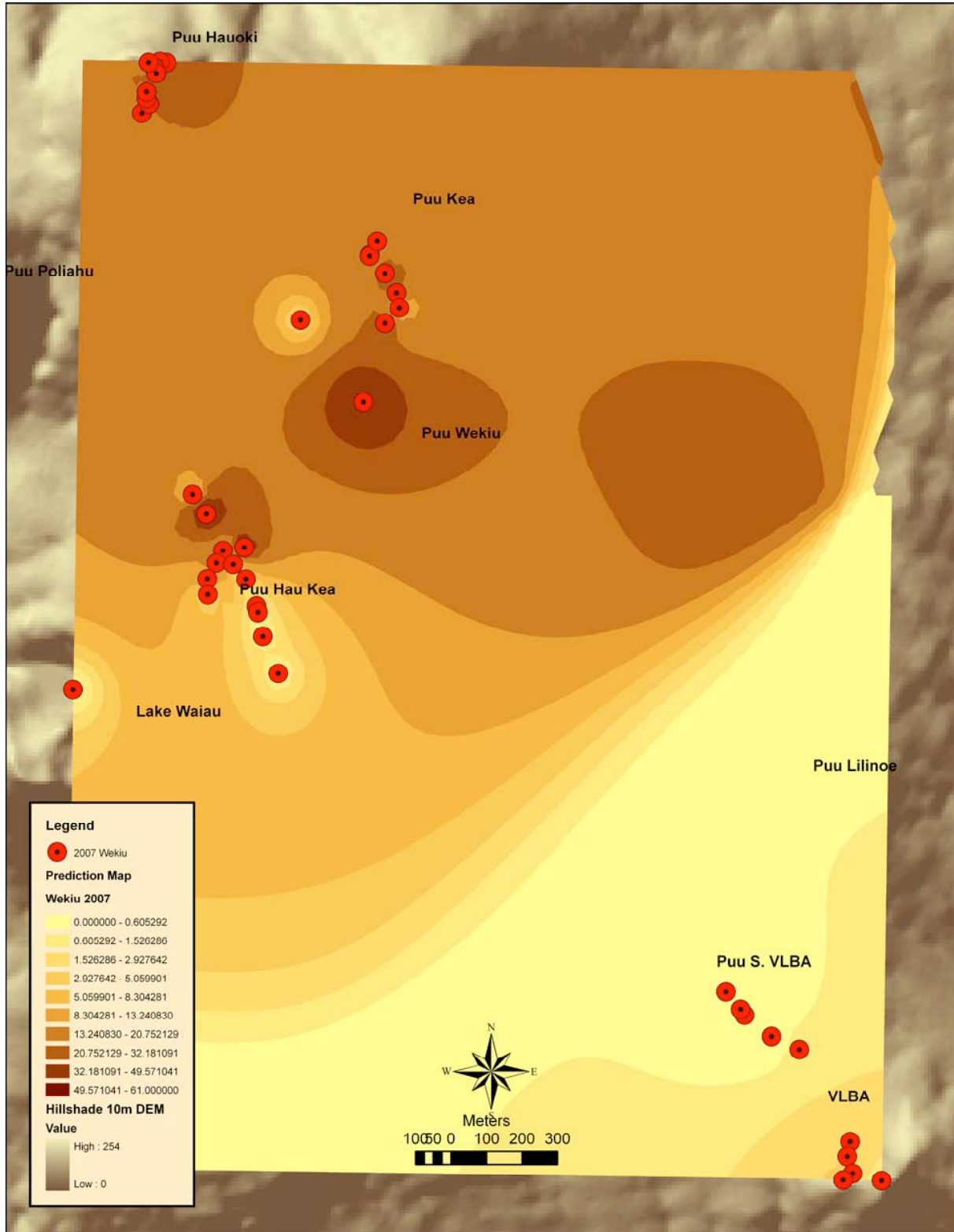


Figure 4. Inverse Distance Weighted model of 2007 wēkiu bug distribution with 2008 wēkiu data incorporated for data validation. Darker areas predicted to have higher bug densities.

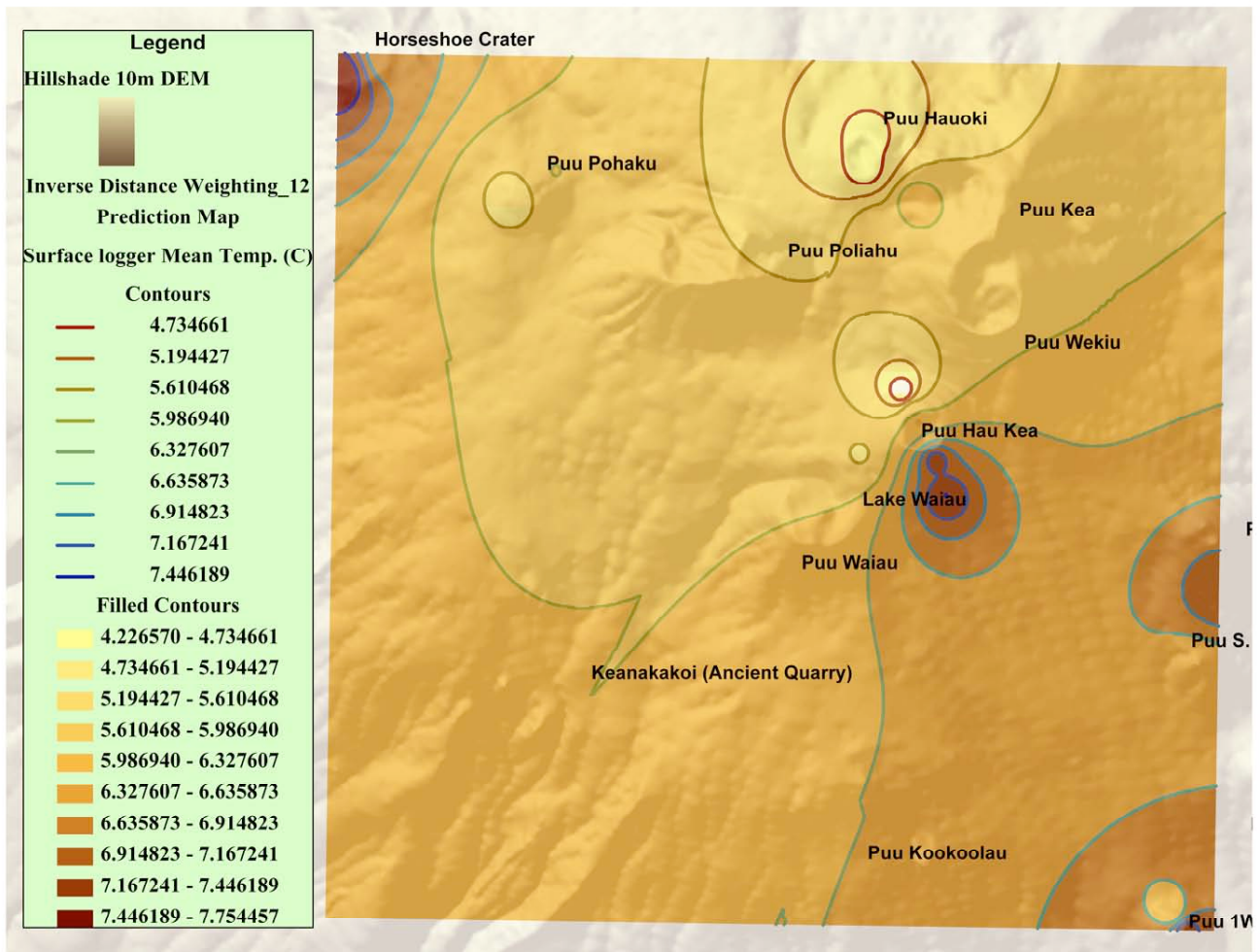


Figure 5. Inverse distance weighted temperature model including all operating surface loggers at the Mauna Kea summit, calculated from over two years of mean surface temperatures, with darker areas having warmer temperatures.

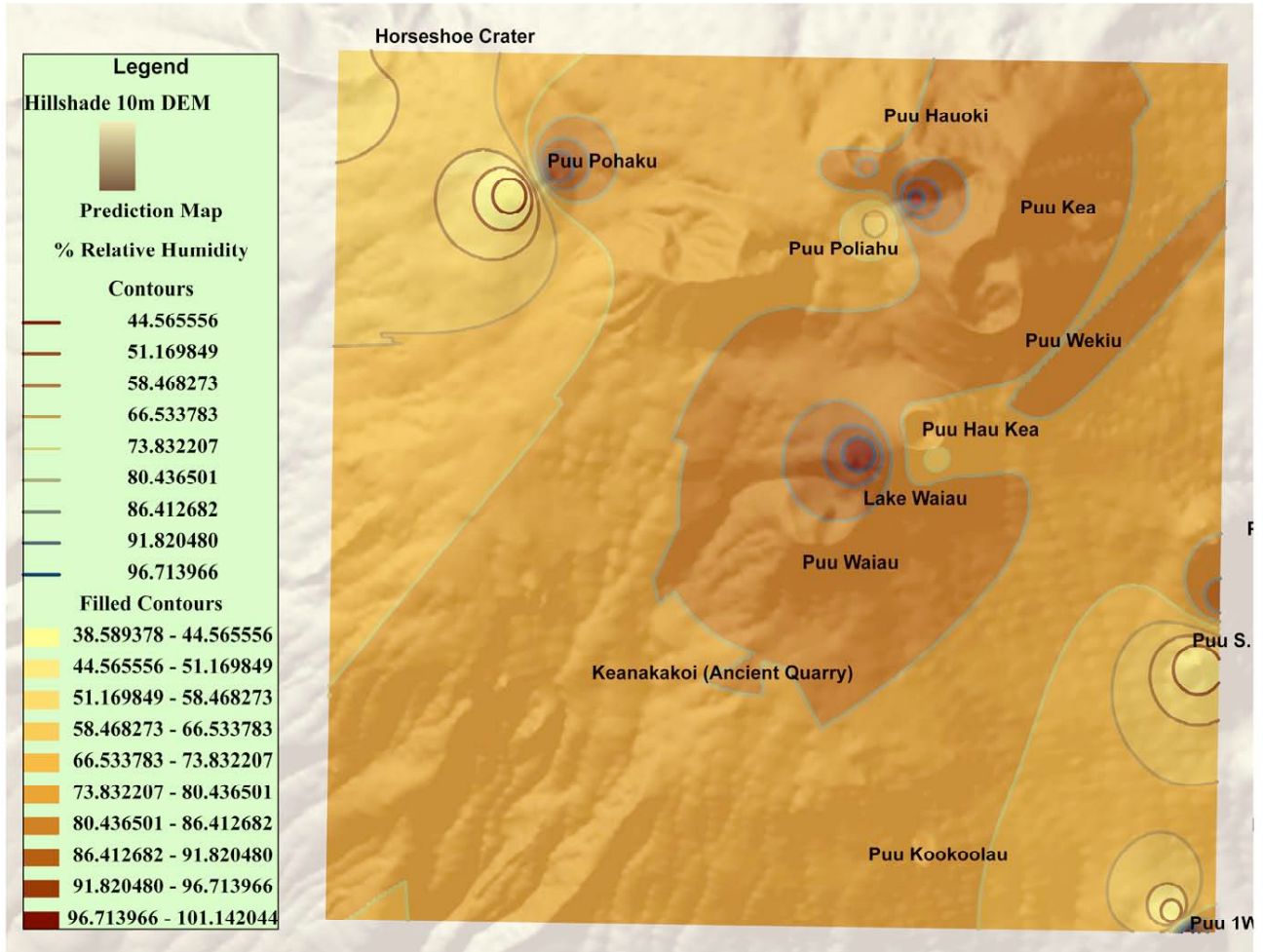


Figure 6. Inverse distance weighted relative humidity model including all operating surface loggers at the Mauna Kea summit, calculated from over two years of mean surface relative humidity data, with darker areas having higher relative humidities.

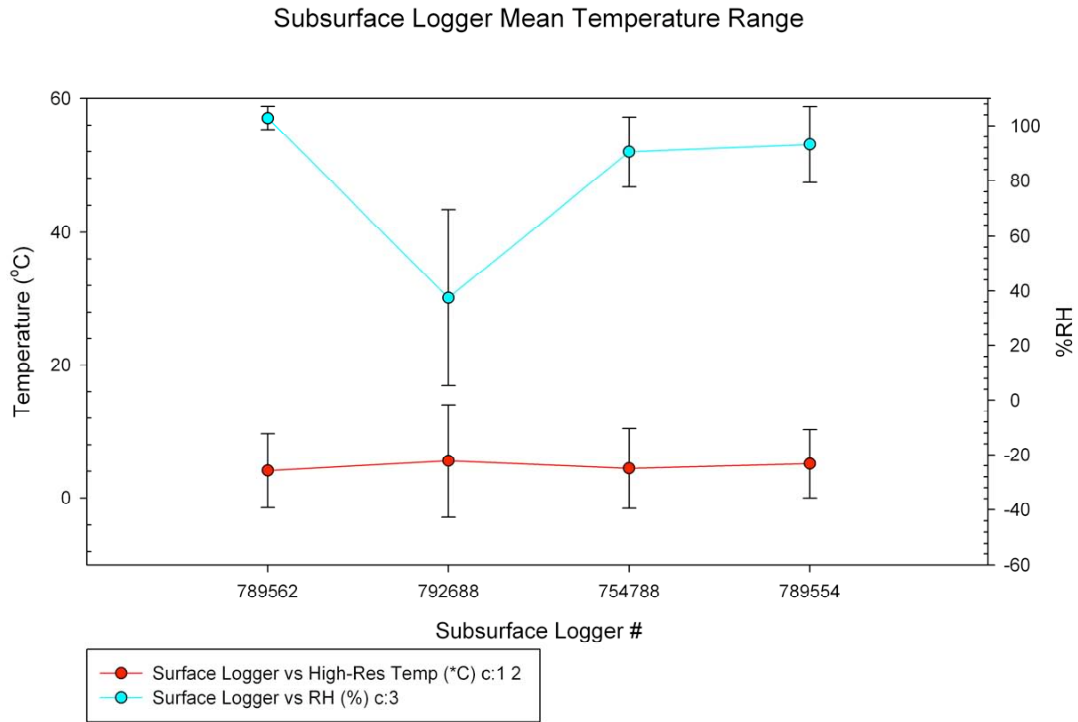


Figure 7. Mean temperatures and relative humidities for all operating SUBSURFACE TEMP/RH loggers at the Mauna Kea summit from Oct. 2006 to July 2008.

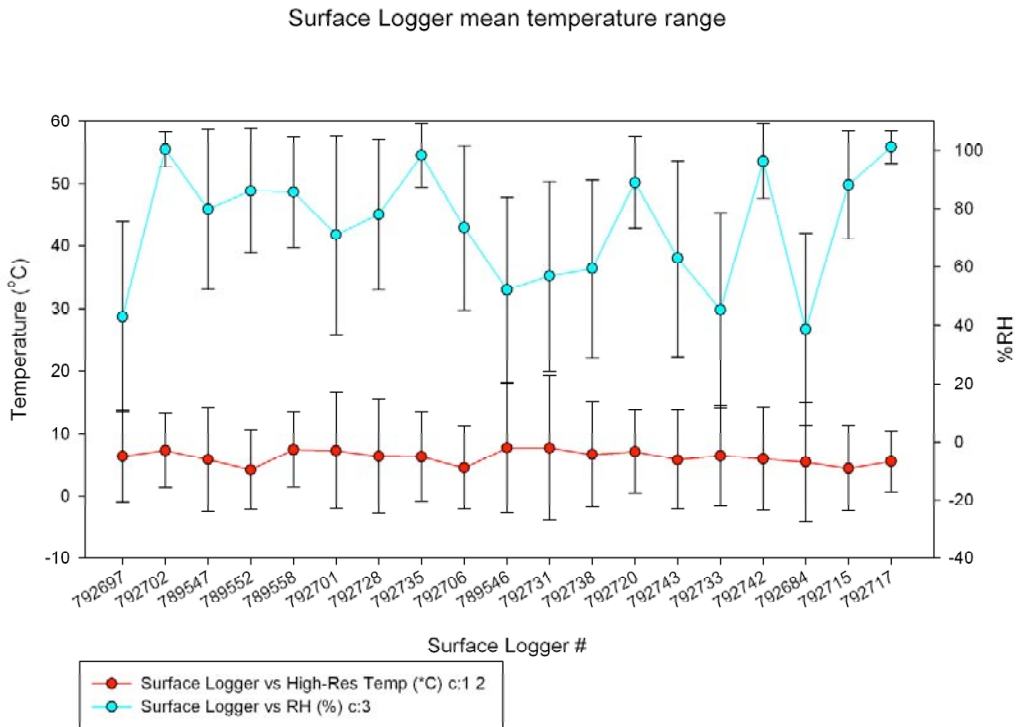


Figure 8. Mean temperatures and relative humidities for all operating SURFACE TEMP/RH loggers at the Mauna Kea summit from Oct 2006 to July 2008.

792697

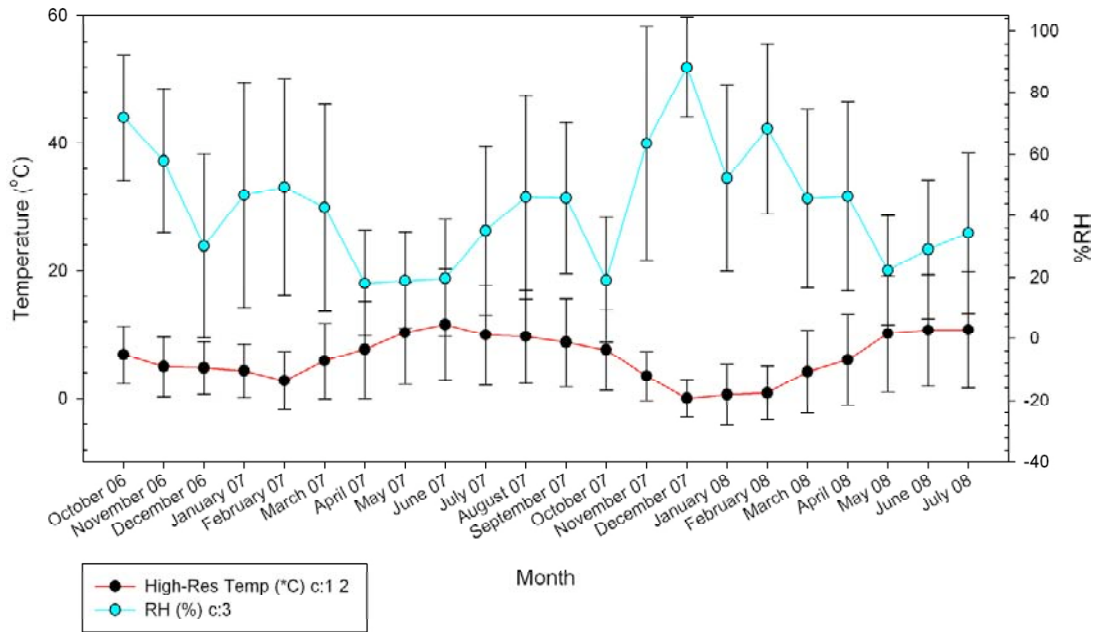


Figure 9. Mean temperature and relative humidity from TEMP/RH Logger S/N#792697 Burns Cone (3702 m), SURFACE, Oct. 2006–July 2008.

792702

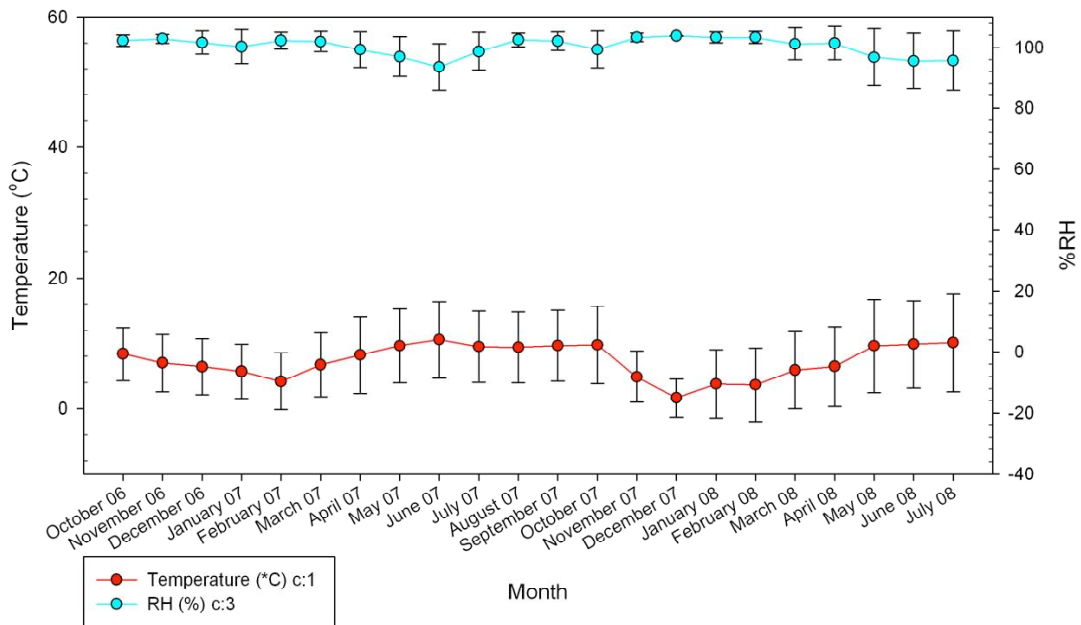


Figure 10. Mean temperature and relative humidity from TEMP/RH Logger S/N#792702 Burns Cone (3700 m), SURFACE Oct. 2006–July 2008.

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789562

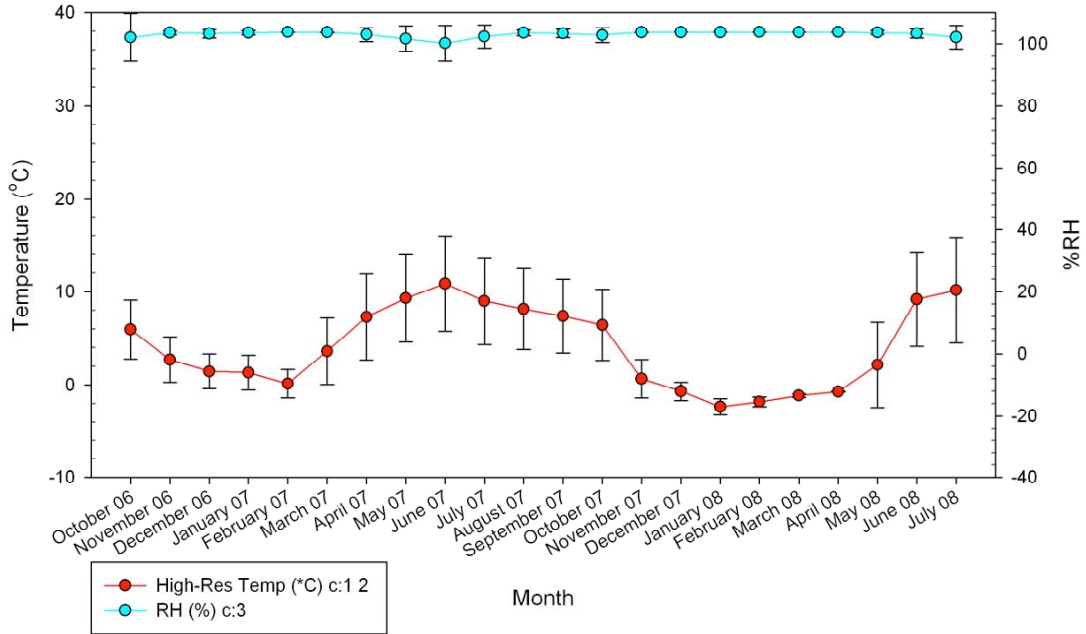


Figure 11. Mean temperature and relative humidity from TEMP/RH Logger S/N#789562 Hau Kea (4081 m), SUBSURFACE Oct. 2006–July 2008.

789547

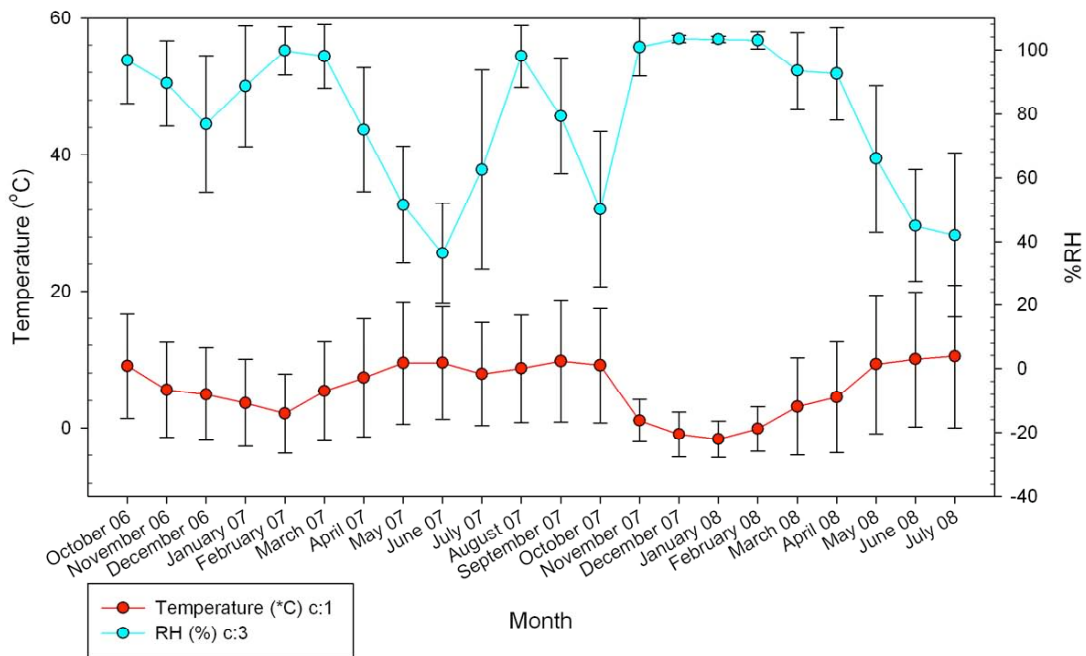


Figure 12. Mean temperature and relative humidity from TEMP/RH Logger S/N#789547 Hau Kea (4096 m), SURFACE Oct. 2006–July 2008.

789552

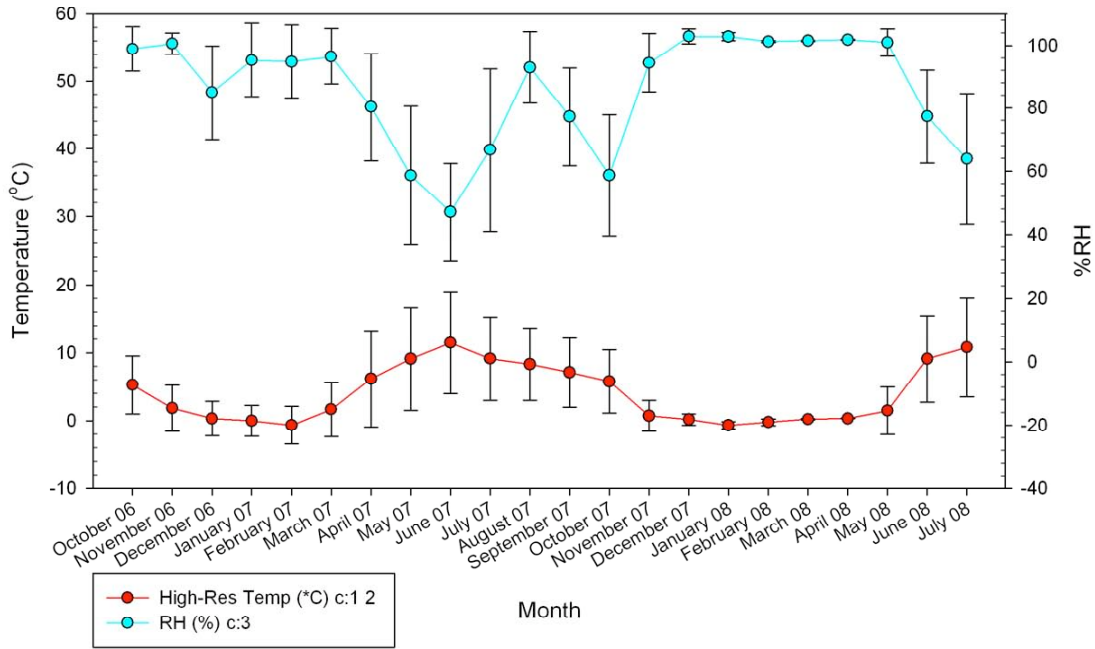


Figure 13. Mean temperature and relative humidity from TEMP/RH Logger S/N#789552 Hau Kea (4058 m), SURFACE Oct. 2006–July 2008.

789558

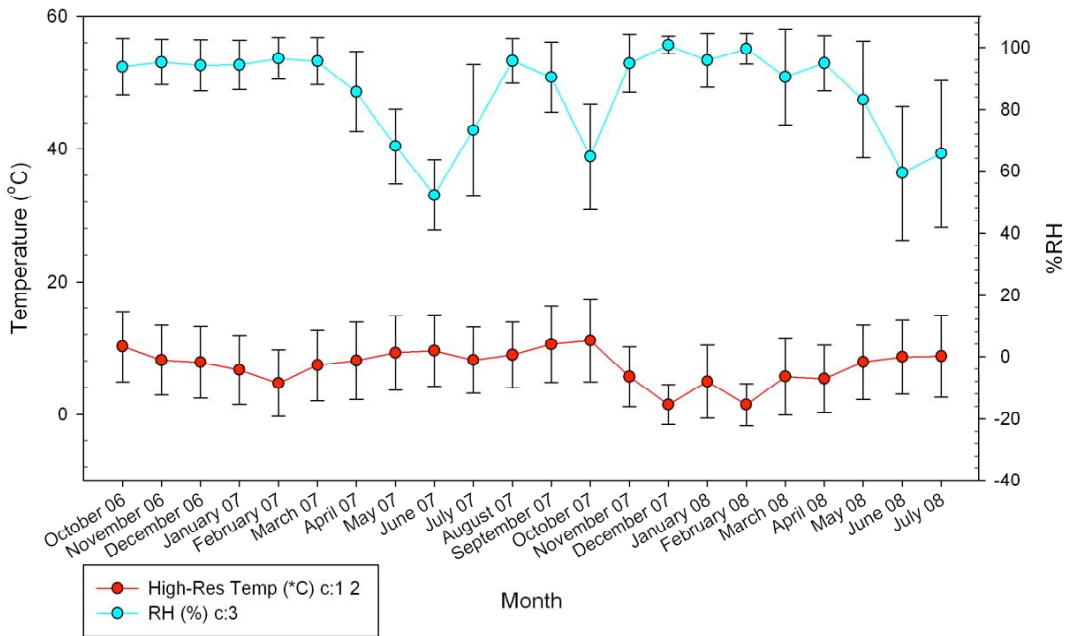


Figure 14. Mean temperature and relative humidity from TEMP/RH Logger S/N#789558 Hau Kea (4006 m), SURFACE Oct. 2006–July 2008.

792701

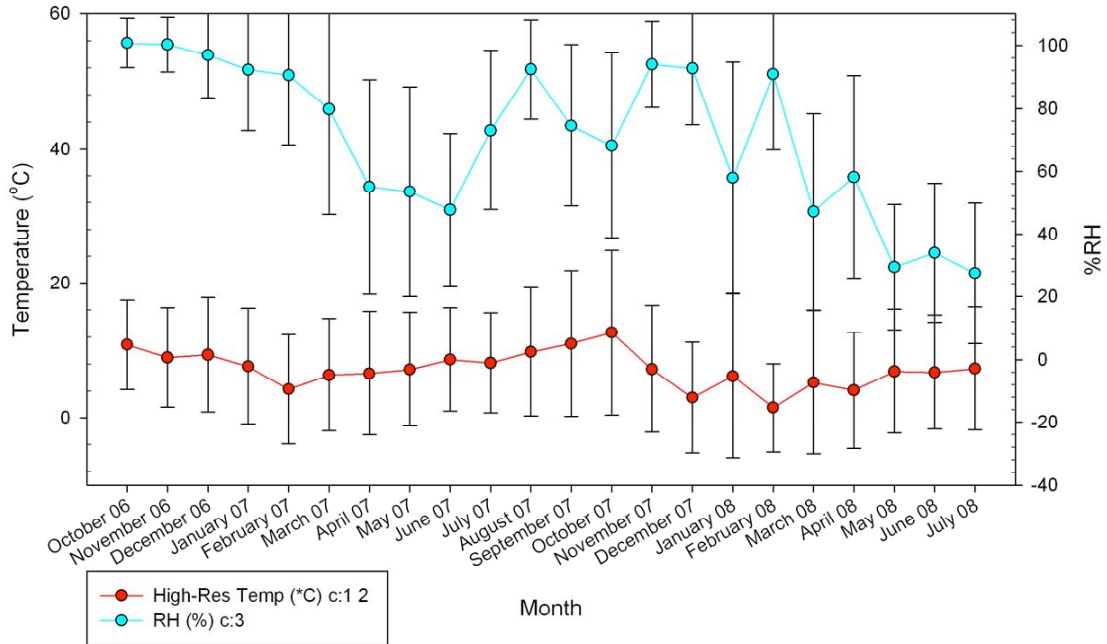


Figure 15. Mean temperature and relative humidity from TEMP/RH Logger S/N#792701 Hau Kea (4096 m), SURFACE Oct 2006–July 2008.

792728

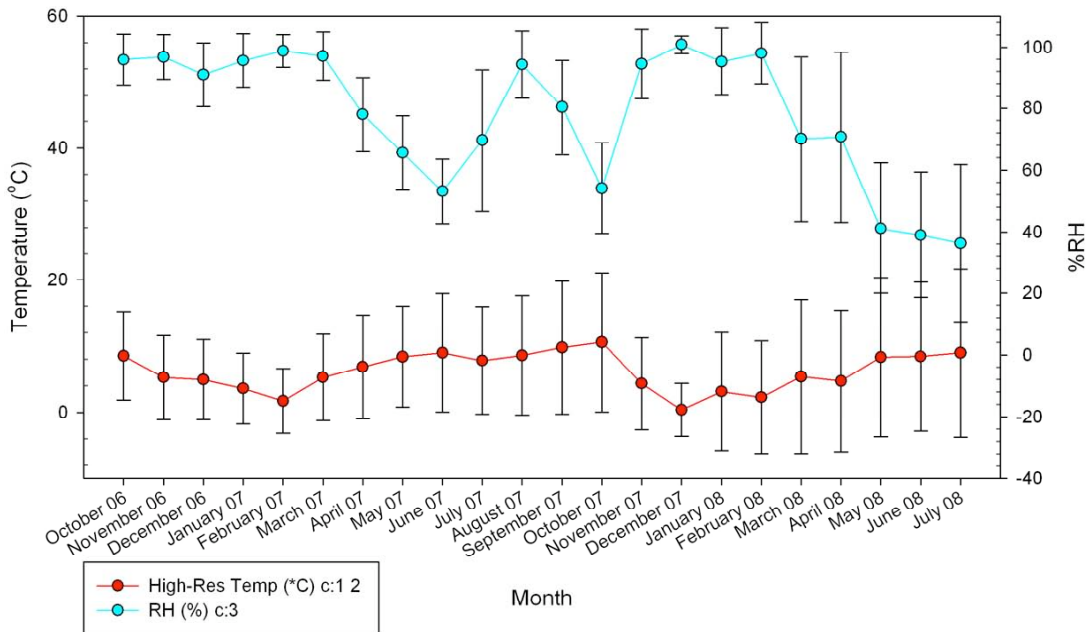


Figure 16. Mean temperature and relative humidity from TEMP/RH Logger S/N#792728 Hau Kea (4105 m), SURFACE Oct. 2006–July 2008.

792735

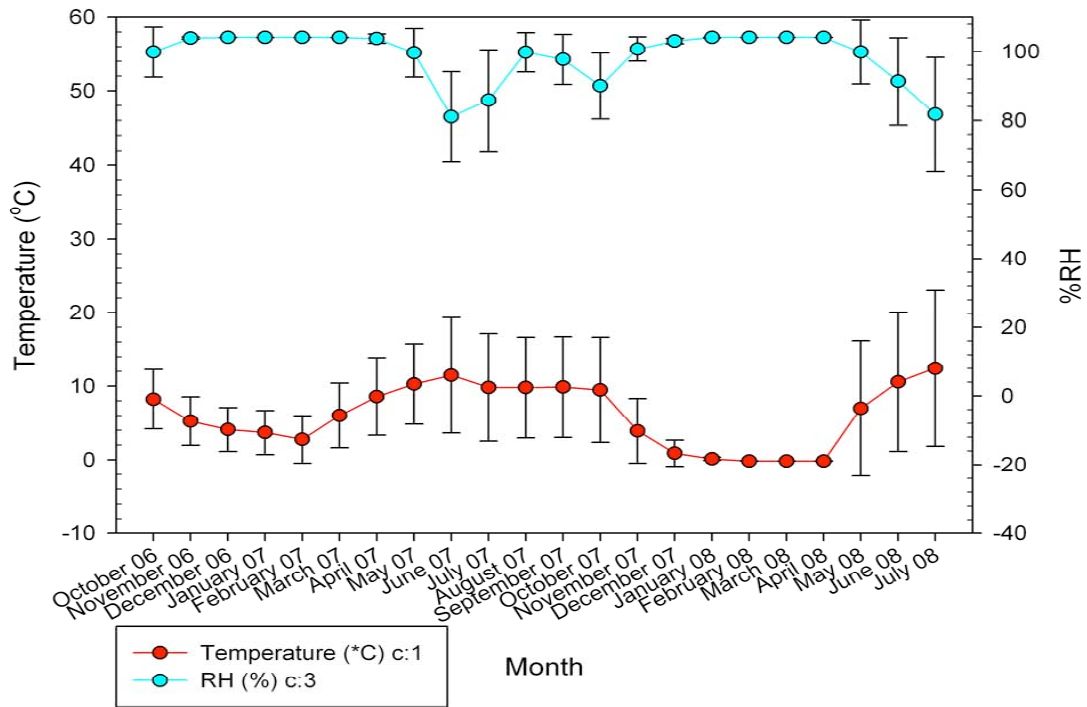


Figure 17. Mean temperature and relative humidity from TEMP/RH Logger S/N#792735 Poi Bowl (4105 m), SURFACE Oct. 2006–July 2008.

792717

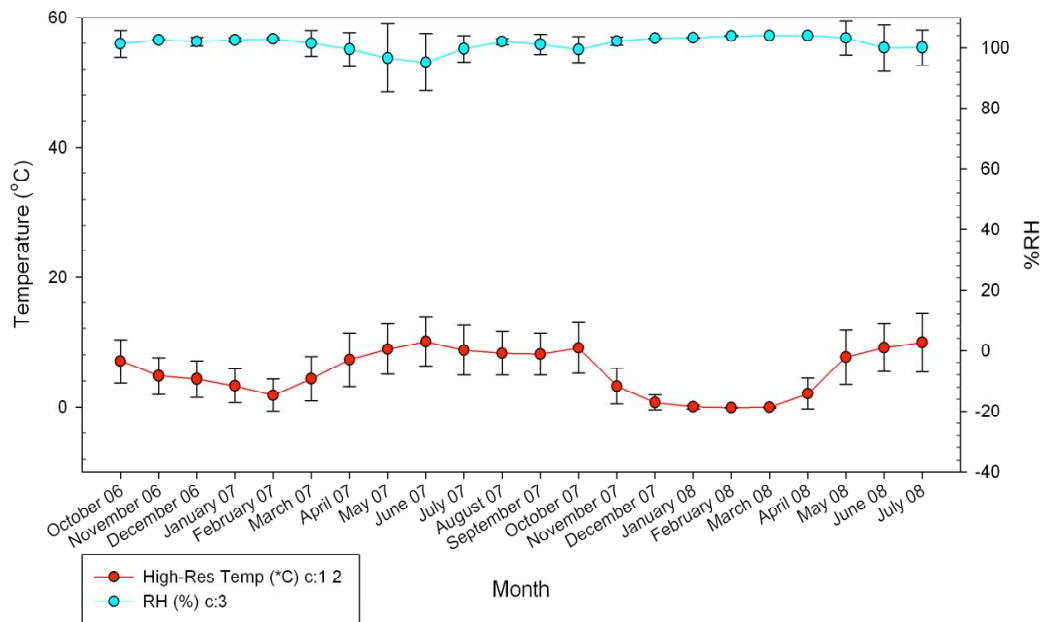


Figure 18. Mean temperature and relative humidity from TEMP/RH Logger S/N#792717 trail to Lake Waiuu (3902 m), SURFACE Oct. 2006–July 2008.

789546

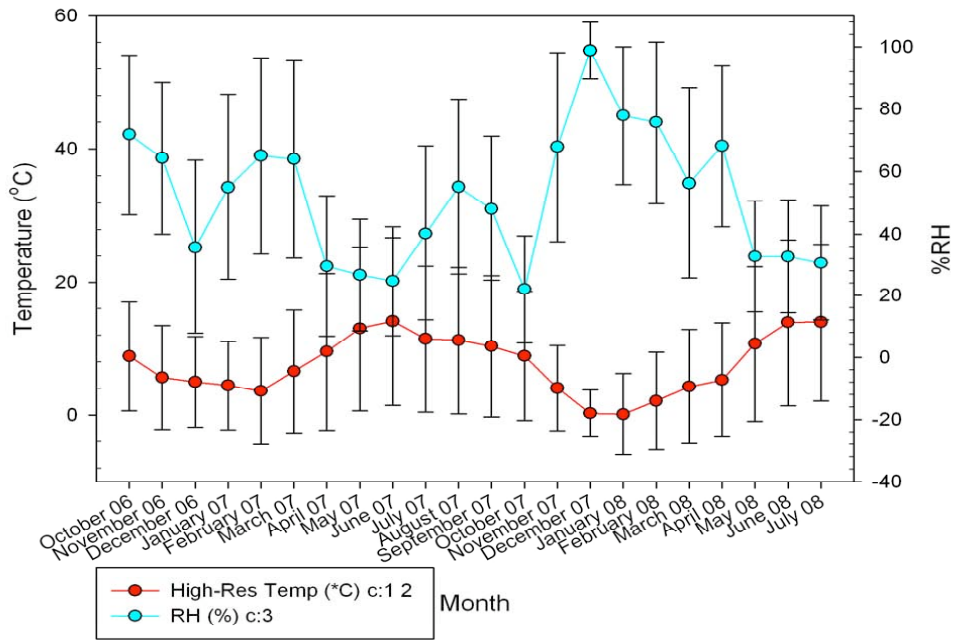


Figure 19. Mean temperature and relative humidity from 1EMP/RH Logger S/N#/789546 Horseshoe Crater (3914 m) SURFACE Oct. 2006–July 2008.

792731

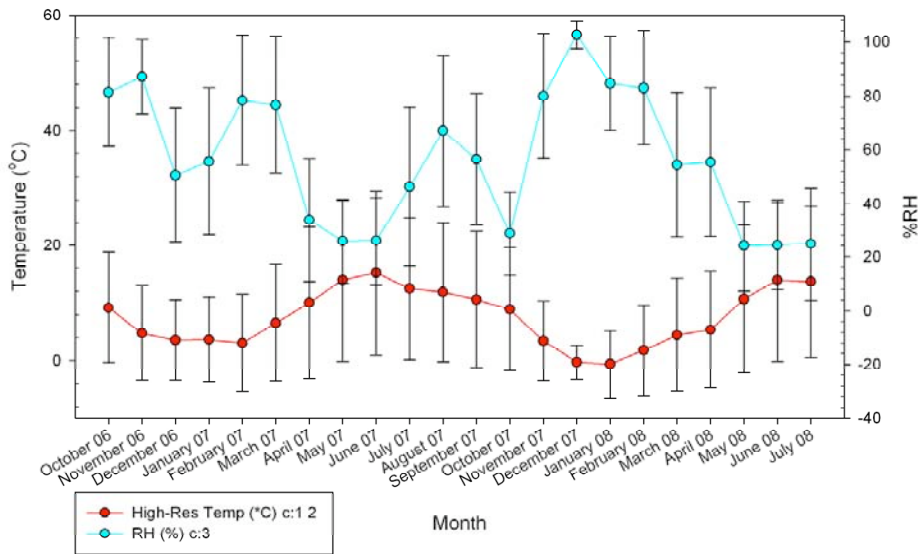


Figure 20
S/N#792731 Horseshoe Crater (3914 m) SURFACE Oct. 2006–July 2008.

RH Logger

789560

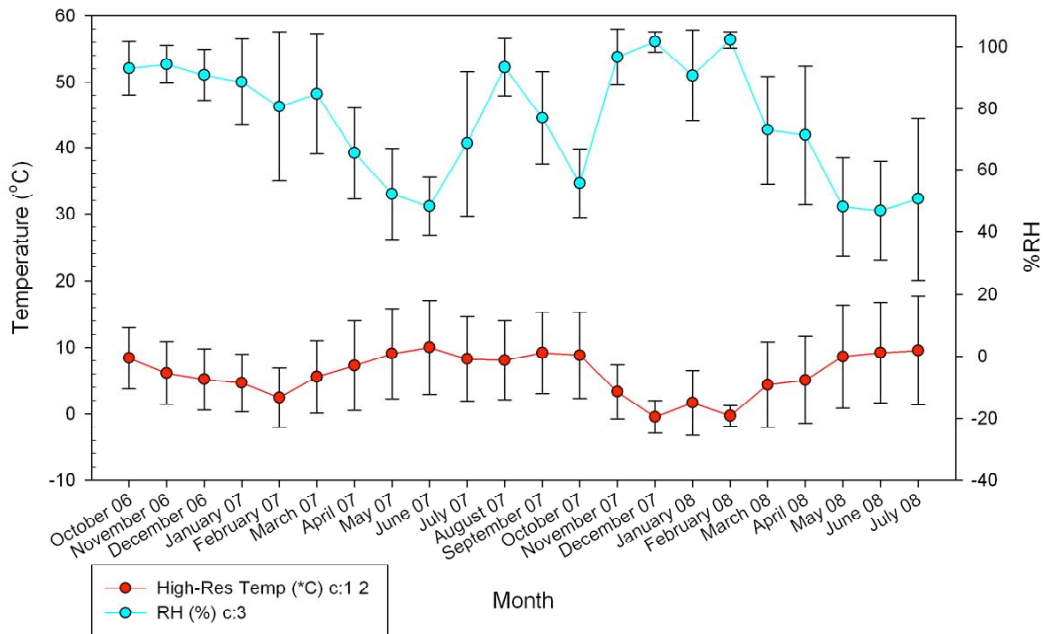


Figure 21. Mean temperature and relative humidity from TEMP/RH Logger S/N#789560 Pu‘u Lilinoe (3843 m) SURFACE Oct. 2006–July 2008.

792720

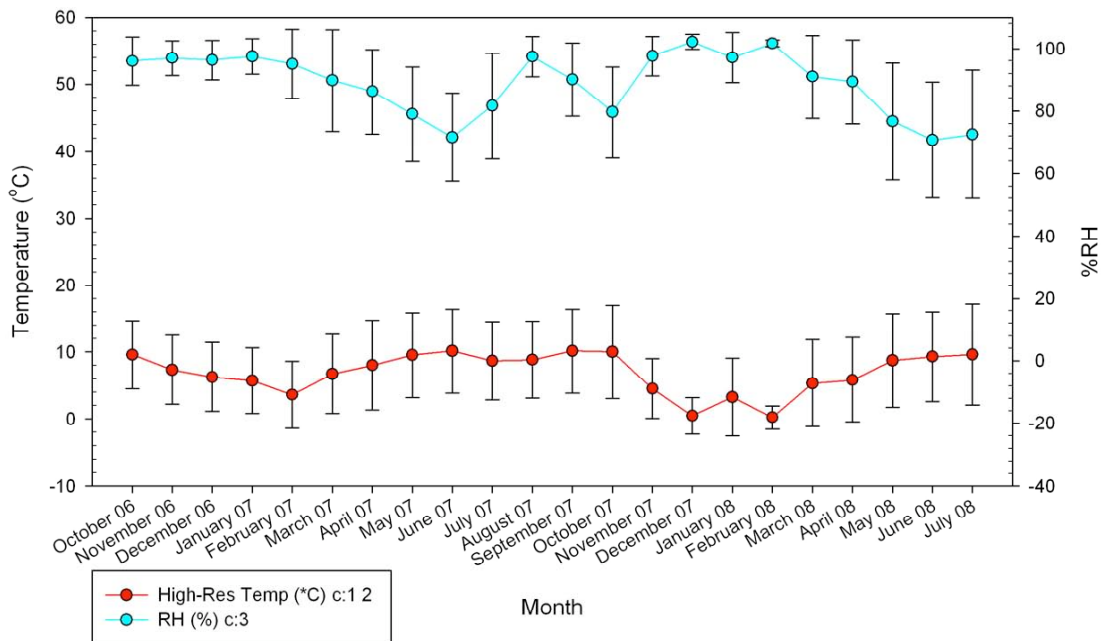


Figure 22. Mean temperature and relative humidity from TEMP/RH Logger S/N#792720 Pu‘u Lilinoe (3843 m) SURFACE Oct. 2006–July 2008.

792743

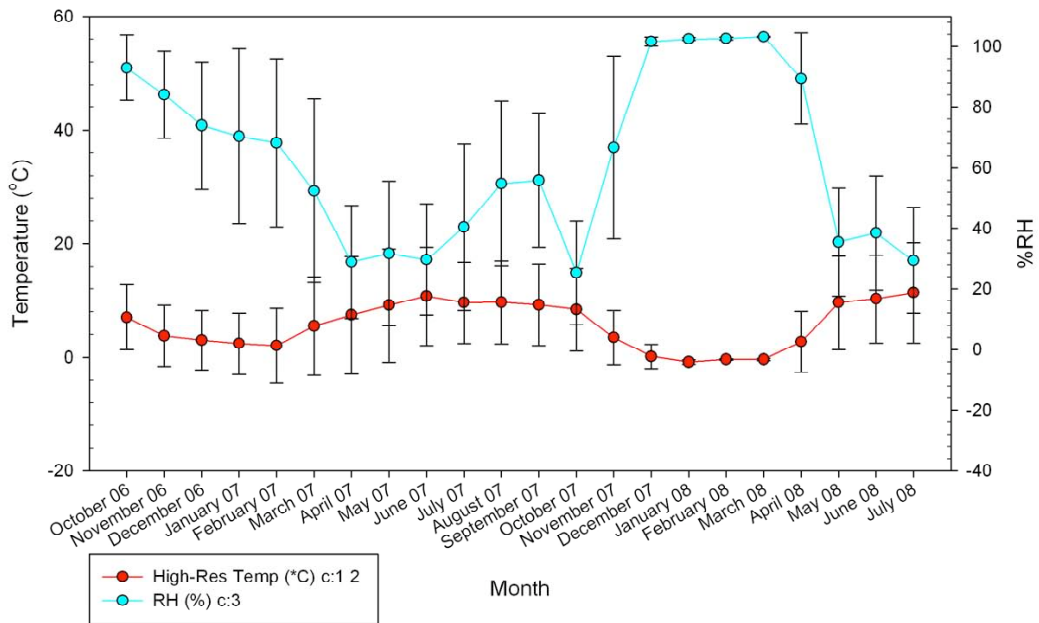


Figure 23. Mean temperature and relative humidity from TEMP/RH Logger S/N#792743 Poi Bowl (4097 m) SURFACE Oct. 2006–July 2008.

792733

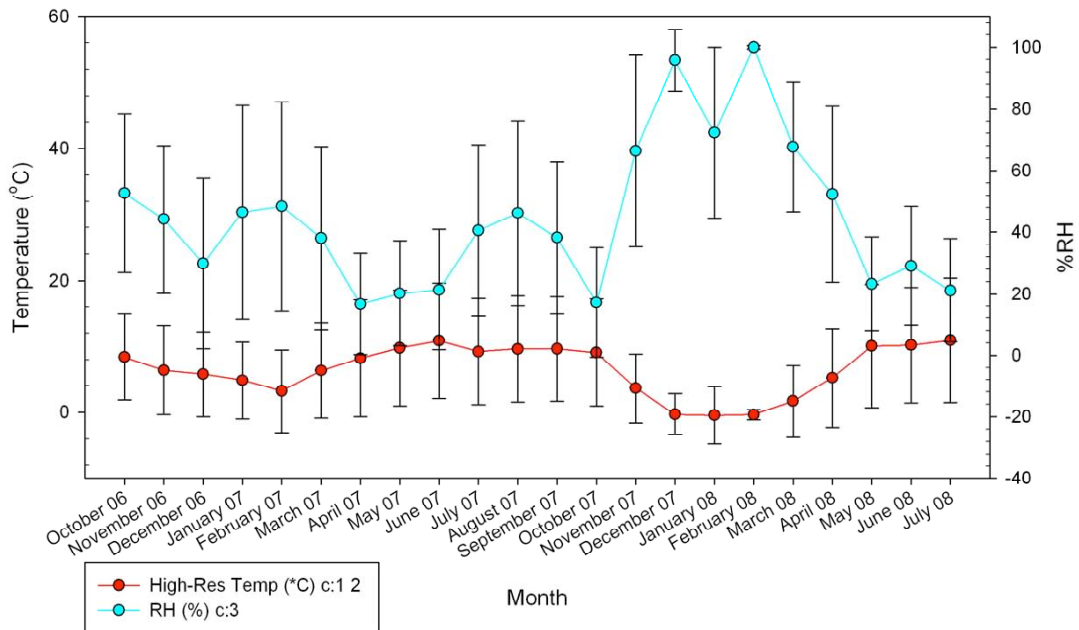


Figure 24. Mean temperature and relative humidity from TEMP/RH Logger S/N#792733 Pu‘u N. VLBA (3850 m) SURFACE Oct. 2006–July 2008.

792688

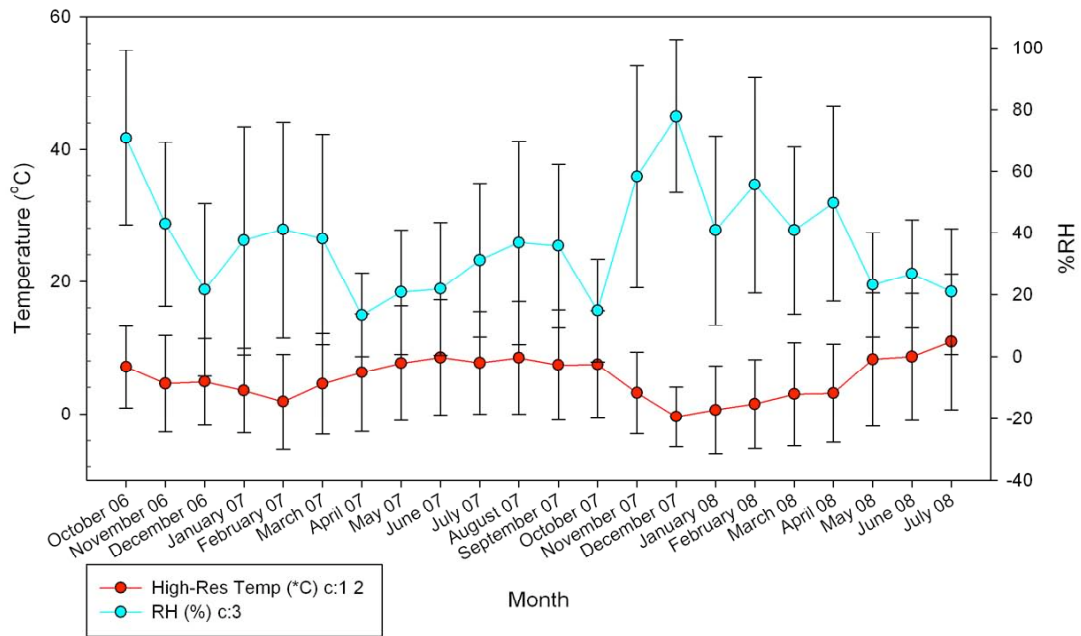


Figure 25. Mean temperature and relative humidity from TEMP/RH Logger S/N#792688 Pu‘u Pohaku (4055 m) SUBSURFACE Oct. 2006–July 2008.

792742

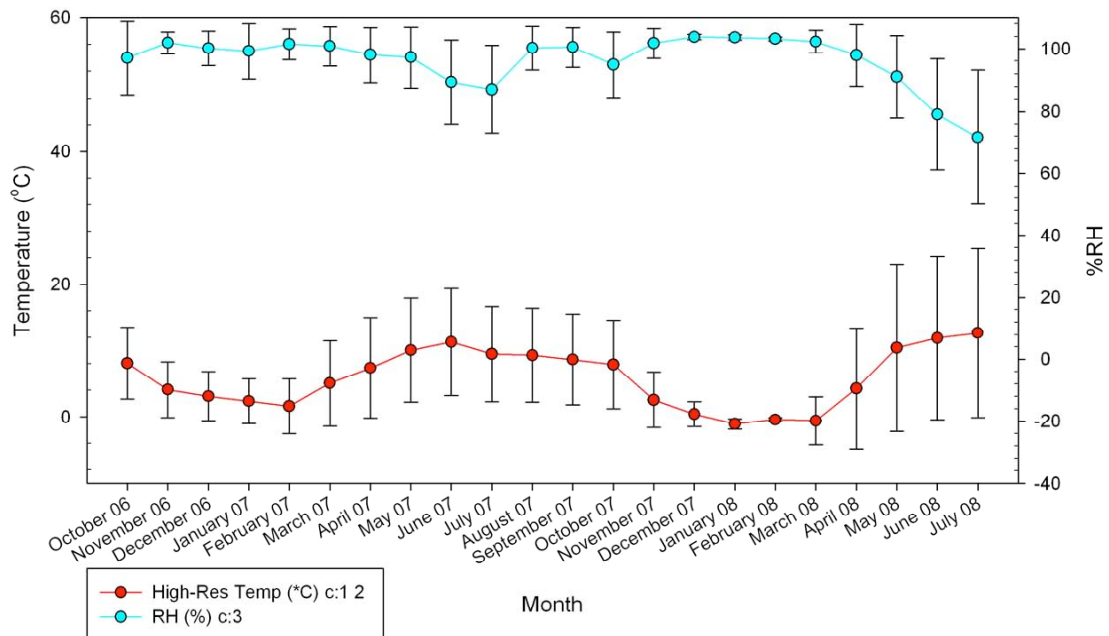


Figure 26. Mean temperature and relative humidity from TEMP/RH Logger S/N#792742 Pu‘u Pohaku (4009 m) SURFACE Oct. 2006–July 2008.

792684

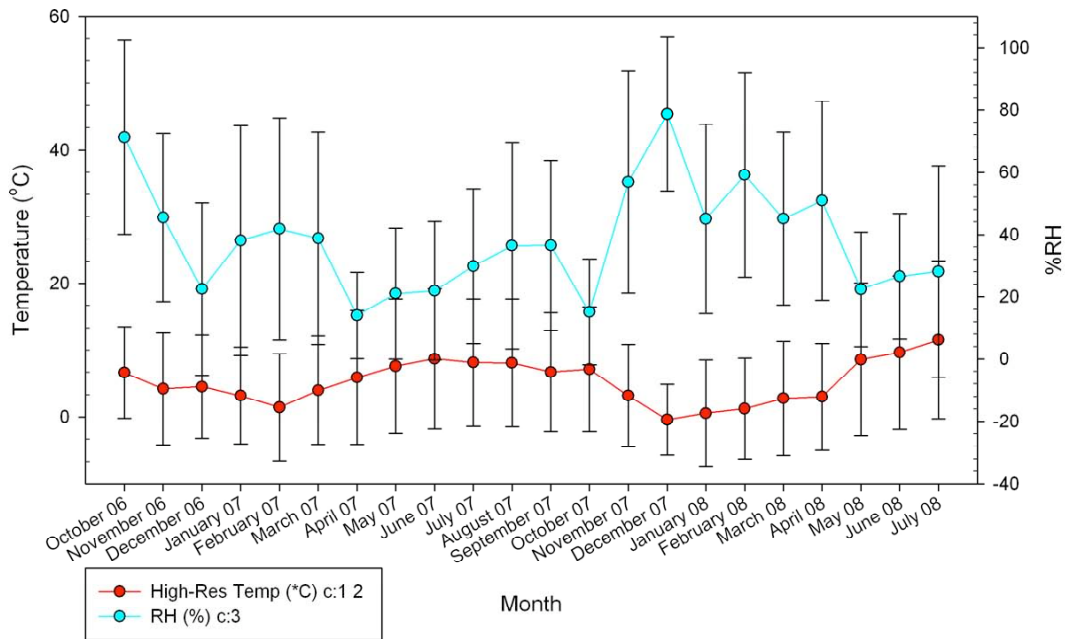


Figure 27. Mean temperature and relative humidity from TEMP/RH Logger S/N#792684 Pu‘u Pohaku (4055 m) SURFACE Oct. 2006–July 2008.

754788

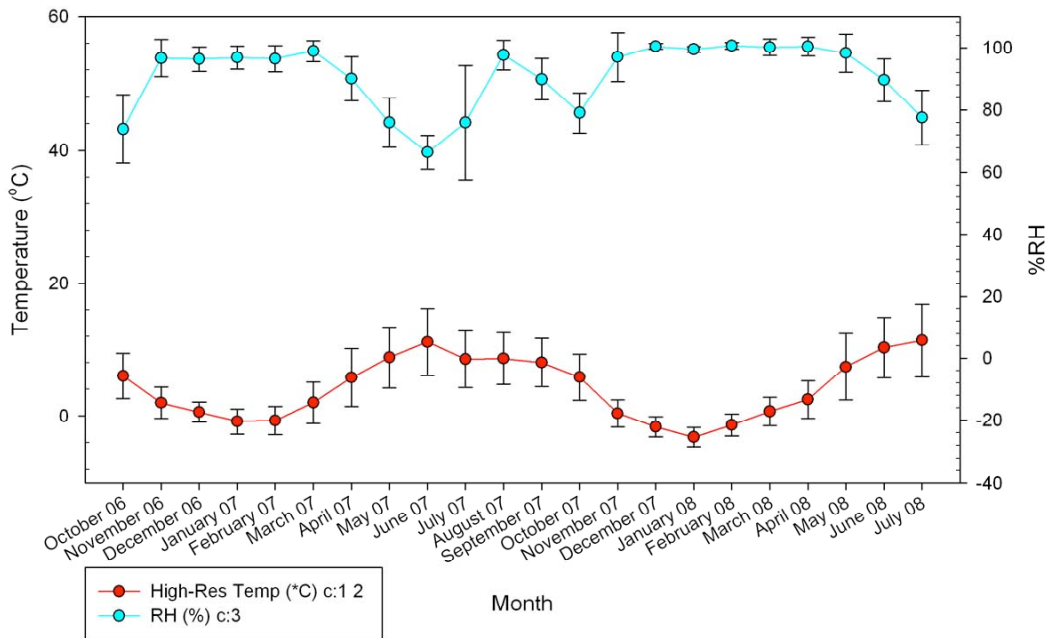


Figure 28. Mean temperature and relative humidity from TEMP/RH Logger S/N#754788 Pu‘u Poliahu (4154 m) SUBSURFACE Oct. 2006–July 2008.

792715

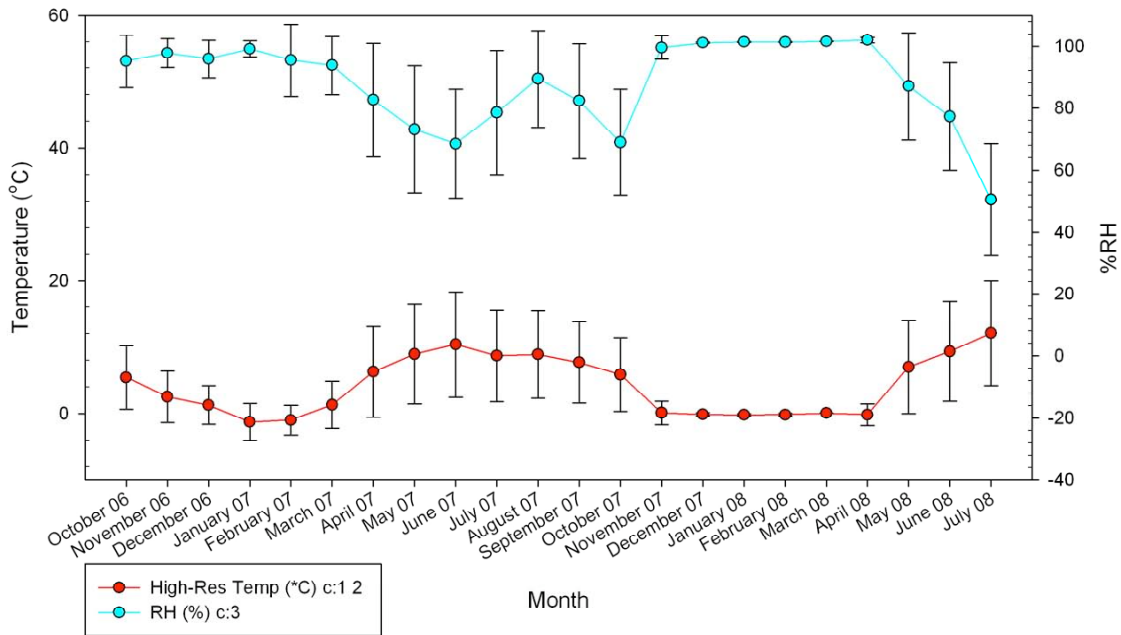


Figure 29. Mean temperature and relative humidity from TEMP/RH Logger S/N#792715 Puu Hau Oki (4143 m) SURFACE Oct. 2006–July 2008.

792706

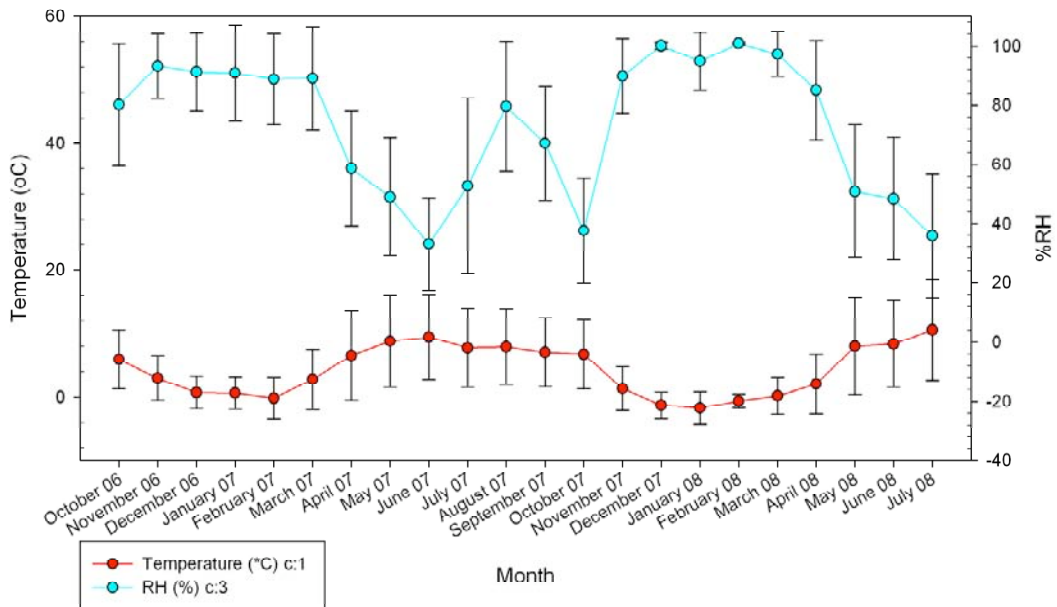


Figure 30. Mean temperature and relative humidity from TEMP/RH Logger S/N#792706 Hau Oki (4,139 m) SURFACE Oct. 2006–July 2008.

APPENDIX B: TABLES

Table 1. Sample locations for alien arthropod sampling for the 2007 field season.

Site No.	Locality	Date	Elevation	GPS (N)	GPS (W)	Habitat/Collection Method	Collectors
1	H.P. Parking lot	8-Jun-07	2857 m	19.76099	155.45624	Ground, parking lot	RE, AV, LE, HL
2	Lake Waiau	8-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, AV, LE, HL
3	Pu 'u Hau Kea	8-Jun-07	4014 m	19.81622	155.47308	wēkiu pitfall trap	RE, AV, LE, HL
4	Hale Pohaku Visitors Center	3-Jun-07	2830 m	19.75934	155.45578	On intro. Aster plant	RE, AV, LE, HL
5	Onizuka Visitors Center	8-Jun-07	2830 m	19.75934	155.45578	parking lot	RE, AV, LE, HL
6	Lake Waiau	8-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, AV, LE, HL
7	Lake Waiau	8-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, AV, LE, HL
8	H.P. Parking lot	8-Jun-07	2857 m	19.76099	155.45624	parking lot	RE, AV, LE, HL
9	Lake Waiau	8-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, AV, LE, HL
10	Onizuka Visitors Center	8-Jun-07	2830 m	19.75934	155.45578	parking lot	RE, AV, LE, HL
11	Pu 'u South of VLBA	6-Jun-07	3780 m	19.79921	155.45590	Cinder, pitfall traps	RE, HL
12	Lake Waiau	8-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, HL
13	H.P. Parking lot	8-Jun-07	2857 m	19.76099	155.45624	parking lot	RE, AV, LE, HL
14	Lake Waiau	8-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, HL
15	Lake Waiau	8-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, AV, LE, HL
16	Batch Plant Parking Lot	7-Jun-07	4045 m	19.82072	155.47495	sticky trap	RE, AV, LE, HL
17	Lake Waiau	5-Jun-07	4003 m	19.81123	155.47701	sticky trap	RE, AV, LE, HL
18	Lake Waiau	5-Jun-07	4003 m	19.81123	155.47701	sticky trap	RE, AV, LE, HL
19	Batch Plant Parking Lot	7-Jun-07	4045 m	19.82072	155.47495	sticky trap	RE, AV, LE, HL
20	Pu 'u Wēkiu	7-Jun-07	4203 m	19.82102	155.46840	cinder	RE, AV, LE, HL

Table 1 (cont.). Sample locations for alien arthropod sampling for the 2007 field season.

Site No.	Locality	Date	Elevation	GPS (N)	GPS (W)	Habitat/Collection Method	Collectors
21	Summit lunch room	6-Jun-07	4226 m	19.82285	155.46994	yellow pan trap	RE, AV, LE, HL
22	Pu'u Hau Oki	7-Jun-07	4118 m	19.82720	155.47523	pitfall	RE, AV, LE, HL
23	Pu'u Wēkiu	4-Jun-07	4173 m	19.82142	155.46848	peanut butter	RE, AV, LE, HL
24	Lake Waiau	5-Jun-07	3968 m	19.81123	155.47701	water, shoreline	RE, AV, LE, HL
25	Gemini telescope	6-Jun-07	4198 m	19.82361	155.46941	sticky trap	RE, AV, LE, HL
26	Lake Waiau	5-Jun-07	3968 m	19.81123	155.47701	shoreline	AV, HL, RE
27	Pu'u Hau Oki	4-Jun-07	4149 m	19.82722	155.47523	pitfall trap	RE, AV
28	Pu'u North of VLBA	6-Jun-07	3834 m	19.80334	155.45897	pitfall trap	RE, LE
29	Puu Wēkiu	4-Jun-07	4185 m	19.82064	155.46878	pitfall trap	RE, AV, LE, HL
30	Batch Plant Parking Lot	7-Jun-07	4045 m	19.82072	155.474951	yellow pan trap	RE, AV, LE, HL
31	Lake Waiau	7-Jun-07	4045 m	19.82072	155.47495	yellow pan trap	RE, AV, LE, HL
32	Gemini telescope	6-Jun-07	4198 m	19.82361	155.46941	outside scope	RE, AV, LE, HL
33	Staff Cook Dorm H.P.	5-Jun-07	2822 m	19.76134	155.45526	bathub	RE, Gordon
34	Gemini telescope	6-Jun-07	4198 m	19.82361	155.46941	outside scope	RE, AV, LE, HL
35	Lake Waiau	5-Jun-07	3968 m	19.81123	155.47701	shoreline	RE, AV, LE, HL
36	VLBA near parking lot	6-Jun-07	3725 m	19.8016	155.45615	yellow pan trap	RE, AV, LE, HL
37	Lower Hau Kea parking lot	6-Jun-07	3898 m	19.81042	155.46745	sticky, yellow pan, peanut butter	RE, AV, LE, HL
38	Batch Plant Parking Lot	7-Jun-07	4045 m	19.82072	155.47495	yellow pan trap	RE, AV, LE, HL
39	Pu'u south of VLBA	9-Jun-07	3761 m	19.79964	155.45605	cinders, live pit fall	RE, AV, LE, HL
40	Pu'u Hau Oki	7-Jun-07	4118 m	19.82720	155.47523	cinders	RE, AV, LE, HL

Table 1 (cont.). Sample locations for alien arthropod sampling for the 2007 field season.

Site No.	Locality	Date	Elevation	GPS (N)	GPS (W)	Habitat/Collection Method	Collectors
41	Summit lunch room	9-Jun-07	4226 m	19.82285	155.46994	sticky trap	RE, AV, LE, HL
42	Summit lunch room	9-Jun-07	4226 m	19.82285	155.46994	yellow pan trap	RE, AV, LE, HL
44	Hale Pohaku	9-Jun-07	2822 m	19.76134	155.45526	glycol pitfall	RE, AV, LE, HL
45	Hale Pohaku	9-Jun-07	2804 m	19.76110	155.45535	glycol pitfall	RE, AV, LE, HL
46	Hau kea	5-Jun-07	3,994 m	19.81265	155.47194	cinder	RE, AV, LE, HL
47	Onizuka Visitors Center	8-Jun-07	9284	19.75934	155.45578	parking lot	RE, AV, LE, HL
48	Trailhead Lake Waiau	9-Jun-07	4027 m	19.81945	155.47487	glycol pitfall	RE, AV, LE, HL
49	Onizuka Visitors Center	8-Jun-07	9284	19.75934	155.45578	parking lot	RE, AV, LE, HL
50	H.P. Parking lot	8-Jun-07	9373	19.76099	155.45624	pitfall trap, around parking lot	RE, AV, LE, HL
51	Gemini telescope	9-Jun-07	13773	19.82361	155.46941	yellow pan trap	RE, AV, LE, HL

Table 2. Shrimp pitfall trap GPS locations (WGS 84) for wēkiu bug surveys conducted in June 2007 (altitudes from taken from altimeter, some variation may occur).

Locality	Trap #	2007 Date Set	Trap Elevation	GPS Coordinates (WGS 84)	Trap Type
Pu'u Hau Kea	1-1	2-8 June, 2007	4014 m	19.81622°N 155.47388°W	Shrimp
Pu'u Hau Kea	2	2-8 June, 2007	4041 m	19.81572°N 155.47350°W	Shrimp
Pu'u Hau Kea	3	2-8 June 2007	4087 m	19.81480°N 155.47304°W	Shrimp
Pu'u Hau Kea	4	2-5 June, 2007	4084 m	19.81489°N 155.47247°W	Shrimp
Pu'u Hau Kea	5	2-5 June, 2007	4090 m	19.81448°N 155.47321°W	Shrimp
Pu'u Hau Kea	6	2-8 June, 2007	4090 m	19.81407°N 155.47345°W	Shrimp
Pu'u Hau Kea	7	2-8 June, 2007	4093 m	19.81367°N 155.47343°W	Shrimp
Pu'u Hau Kea	8	2-8 June, 2007	4075 m	19.81445°N 155.47276°W	Shrimp
Pu'u Hau Kea	9	2-8 June, 2007	4051 m	19.81408°N 155.47241°W	Shrimp
Pu'u Hau Kea	10	2-8 June, 2007	4078 m	19.81340°N 155.47212°W	Shrimp
Pu'u Hau Kea	11	2-8 June, 2007	4093 m	19.81325°N 155.47208°W	Shrimp
Pu'u Hau Kea	12	2-8 June, 2007	4060 m	19.81265°N 155.47194°W	Shrimp
Pu'u Hau Kea	13	2-8 June, 2007	4005 m	19.81172°N 155.47151°W	Shrimp
Pu'u Wēkiu	T1	1-7 June, 2007	4188 m	19.82273°N 155.46902°W	Shrimp
Pu'u Wēkiu	T5B	1-7 June, 2007	4185 m	19.81862°N 155.46933°W	Shrimp
Pu'u Wēkiu	T6	1-7 June, 2007	4179 m	19.82238°N 155.46922°W	Shrimp

Table 2 (cont.). Shrimp pitfall trap GPS locations (WGS 84) for wēkiu bug surveys conducted in June 2007 (altitudes from taken from altimeter, some variation may occur).

Locality	Trap #	2007 Date Set	Trap Elevation	GPS Coordinates (WGS 84)	Trap Type
Pu'u Wēkiu	T6B	1-7 June, 2007	4200 m	19.8223564°N 155.46922°W	Shrimp
Pu'u Wēkiu	T7	1-7 June, 2007	4164 m	19.82192°N 155.46880°W	Shrimp
Pu'u Wēkiu	T8-1	1-7 June, 2007	4173 m	19.82142°N 155.46848°W	Shrimp
Pu'u Wēkiu	T9-1	1-7 June, 2007	4185 m	19.82104°N 155.46840°W	Shrimp
Pu'u Wēkiu	T11-1	1-7 June, 2007	4,134 m	19.82069°N 155.47105°W	Shrimp
Pu'u Wēkiu	T20	1-7 June, 2007	4179 m	19.82273°N 155.46902°W	Shrimp
Pu'u Wēkiu	T21	1-7 June, 2007	4185 m	19.82064°N 155.46878°W	Shrimp
Lake Waiau	W-1	2-9 June, 2007	3969 m	19.81123°N 155.47701°W	Glycol
Pu'u of S. VLBA	S1	3-9 June, 2007	3746 m	19.80001°N 155.45598°W	Shrimp
Pu'u of S. VLBA	S2	3-9 June, 2007	3761 m	19.79964°N 155.45605°W	Shrimp
Pu'u of S. VLBA	S3	3-9 June, 2007	3780 m	19.79921°N 155.45590°W	Shrimp
Pu'u of S. VLBA	S4	3-9 June, 2007	3780 m	19.79904°N 155.45615°W	Shrimp
Pu'u of S. VLBA	S5	3-9 June, 2007	3786 m	19.79904°N 155.45512°W	Shrimp
Pu'u N. of VLBA (Midway up Pu'u)	N1	3-9 June, 2007	3752 m	19.80234°N 155.45738°W	Shrimp
Pu'u N. of VLBA (Midway up Pu'u)	N2	3-9 June, 2007	3789 m	19.80266°N 155.45813°W	Shrimp
Pu'u N. of VLBA (Midway up Pu'u)	N3	3-9 June, 2007	3825 m	19.80319°N 155.45886°W	Shrimp
Pu'u N. of VLBA (Midway up Pu'u)	N4	3-9 June, 2007	3834 m	19.80334°N 155.45897°W	Shrimp
Pu'u N. of VLBA (Pu'u summit towards Pu'u Wēkiu)	N5	3-9 June, 2007	3837 m	19.80378°N 155.45937°W	Shrimp
Pu'u Hau Oki	T1	1-7 June 2007	4168 m	19.82722°N 155.47475°W	Shrimp
Pu'u Hau Oki	T2	1-7 June 2007	4158 m	19.82722°N 155.47493°W	Shrimp

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Table 2 (cont.). Shrimp pitfall trap GPS locations (WGS 84) for wēkiu bug surveys conducted in June 2007 (altitudes from taken from altimeter, some variation may occur).

Locality	Trap #	2007 Date Set	Trap Elevation	GPS Coordinates (WGS 84)	Trap Type
Pu'u Hau Oki	T3	1-7 June 2007	4147 m	19.82707°N 155.47507°W	Shrimp
Pu'u Hau Oki	T4	1-7 June 2007	4159 m	19.82693°N 155.47502°W	Shrimp
Pu'u Hau Oki	T5	1-7 June 2007	4149 m	19.82720°N 155.47523°W	Shrimp
Pu'u Hau Oki	T6B-1	1-7 June, 2007	4170 m	19.82590°N 155.47539°W	Shrimp
Pu'u Hau Oki	T7B	1-7 June, 2007	4174 m	19.82614°N 155.47519°W	Shrimp
Pu'u Hau Oki	T8B-1	1-7 June, 2007	4161 m	19.82628°N 155.47527°W	Shrimp
Pu'u Hau Oki	T9B	1-7 June, 2007	4158 m	19.82645°N 155.47527°W	Shrimp

Table 3. Sample locations for alien arthropod sampling for the 2008 field season.

Site No.	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
70	Park. Lot by Hale Pohaku, Near old water tanks	1A	July 19-25, 2008	2823 m	19.76051°N 155.45607°W	Sticky
71	Park. Lot by Hale Pohaku, Near old water tanks	1A	July 19-25, 2008	2823 m	19.76051°N 155.45607°W	Peanut Butter
72	Park. Lot by Hale Pohaku, Near old water tanks	1A	July 19-25, 2008	2823 m	19.76051°N 155.45607°W	Yellow Pan Trap
73	Park. Lot by Hale Pohaku, Near old water tanks	1A	July 19-25, 2008	2823 m	19.76051°N 155.45607°W	Pitfall: Glycol, Shrimp Paste
74	Park. Lot by Hale Pohaku	2A	July 19-25, 2008	2847 m	19.76089°N 155.45624°W	Sticky
75	Park. Lot by Hale Pohaku	2A	July 19-25, 2008	2847 m	19.76089°N 155.45624°W	Yellow Pan Trap
76	Park. Lot by Hale Pohaku	2A	July 19-25, 2008	2847 m	19.76089°N 155.45624°W	Pitfall: Glycol, Shrimp Paste
77	Park. Lot by Hale Pohaku	2A	July 19-25, 2008	2847 m	19.76089°N 155.45624°W	Peanut Butter
78	Park. Lot by Hale Pohaku	3A	July 19-25, 2008	2852 m	19.76111°N 155.45644°W	Pitfall: Glycol, Shrimp Paste
79	Park. Lot by Hale Pohaku	3A	July 19-25, 2008	2852 m	19.76111°N 155.45644°W	Sticky
80	Park. Lot by Hale Pohaku	3A	July 19-25, 2008	2852 m	19.76111°N 155.45644°W	Yellow Pan Trap
81	Park. Lot by Hale Pohaku	3A	July 19-25, 2008	2852 m	19.76111°N 155.45644°W	Peanut Butter
82	Park. Lot by Hale Pohaku	4A	July 19-25, 2008	2851 m	19.76105°N 155.45602°W	Sticky
83	Park. Lot by Hale Pohaku	4A	July 19-25, 2008	2851 m	19.76105°N 155.45602°W	Pitfall: Glycol, Shrimp Paste
84	Park. Lot by Hale Pohaku	4A	July 19-25, 2008	2851 m	19.76105°N 155.45602°W	Yellow Pan Trap
85	Park. Lot by Hale Pohaku	4A	July 19-25, 2008	2851 m	19.76105°N 155.45602°W	Peanut Butter
86	Onizuka Visitor Center	5A	July 19-25, 2008	2828 m	19.75932°N 155.45573°W	Peanut Butter
87	Onizuka Visitor Center	5A	July 19-25, 2008	2828 m	19.75932°N 155.45573°W	Sticky
88	Onizuka Visitor Center	5A	July 19-25, 2008	2828 m	19.75932°N 155.45573°W	Pitfall: Glycol, Shrimp Paste

Table 3 (cont.). Sample locations for alien arthropod sampling for the 2008 field season.

Site No.	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
89	Onizuka Visitor Center	5A	July 19-25, 2008	2828 m	19.75932°N 155.45573°W	Yellow Pan Trap
90	Onizuka Visitor Center	6A	July 19-25, 2008	2829 m	19.75943°N 155.45587°W	Peanut Butter
91	Onizuka Visitor Center	6A	July 19-25, 2008	2829 m	19.75943°N 155.45587°W	Pitfall: Glycol, Shrimp Paste
92	Onizuka Visitor Center	6A	July 19-25, 2008	2829 m	19.75943°N 155.45587°W	Yellow Pan Trap
93	Onizuka Visitor Center	6A	July 19-25, 2008	2829 m	19.75943°N 155.45587°W	Sticky
94	Onizuka Visitor Center	7A	July 19-25, 2008	2832 m	19.75945°N 155.45607°W	Pitfall: Glycol, Shrimp Paste
95	Onizuka Visitor Center	7A	July 19-25, 2008	2832 m	19.75945°N 155.45607°W	Peanut Butter
96	Onizuka Visitor Center	7A	July 19-25, 2008	2832 m	19.75945°N 155.45607°W	Yellow Pan Trap
97	Onizuka Visitor Center	7A	July 19-25, 2008	2832 m	19.75945°N 155.45607°W	Sticky
98	Onizuka Visitor Center	8A	July 19-25, 2008	2826 m	19.75916°N 155.45580°W	Peanut Butter
99	Onizuka Visitor Center	8A	July 19-25, 2008	2826 m	19.75916°N 155.45580°W	Yellow Pan Trap
100	Onizuka Visitor Center	8A	July 19-25, 2008	2826 m	19.75916°N 155.45580°W	Sticky
101	Onizuka Visitor Center	8A	July 19-25, 2008	2826 m	19.75916°N 155.45580°W	Pitfall: Glycol, Shrimp Paste
102	11,000 Ft. Marker	PB1	July 20-26, 2008	3336 m	19.77680°N 155.45222°W	2 Peanut Butter
103	12,000 Ft. Marker	PB2	July 20-26, 2008	3674 m	19.79544°N 155.45908°W	2 Peanut Butter

Table 3 (cont.). Sample locations for alien arthropod sampling for the 2008 field season.

Site No	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
104	13,000 Ft. Marker	PB3	July 20-27, 2008	3912 m	19.81047°N 155.46758°W	2 Peanut Butter
105	13,000 ft Parking Lot	PB 3	20 July 2008	3912 m	19.81047°N 155.46758°W	2 Peanut Butter
106	13,000 ft Parking Lot	PB 3	20 July 2008	3912 m	19.81047°N 155.46758°W	Pitfall: Glycol, Shrimp Paste
107	13,000 ft Parking Lot	PB 3	20 July 2008	3912 m	19.81047°N 155.46758°W	Yellow Pan Trap
108	13,000 ft Parking Lot	PB 3	20 July 2008	3912 m	19.81047°N 155.46758°W	3-Sticky
109	Lake Waiau (Trailhead), Batch Plant	13260 1/5	July 20-26, 2008	4042 m	19.82174°N 155.47517°W	Peanut Butter
110	Lake Waiau (Trailhead), Batch Plant	13260 1/5	July 20-26, 2008	4042 m	19.82174°N 155.47517°W	Pitfall: Glycol, Shrimp Paste
111	Lake Waiau (Trailhead), Batch Plant	13260 1/5	July 20-26, 2008	4042 m	19.82174°N 155.47517°W	Sticky
112	Lake Waiau (Trailhead), Batch Plant	13260 1/5	July 20-26, 2008	4042 m	19.82174°N 155.47517°W	Yellow Pan Trap
113	Lake Waiau (Trailhead), Batch Plant-Upper Hau Kea Parking Lot	13350 2/5	July 20-26, 2008	4069 m	19.82096°N 155.47493°W	Pitfall: Glycol, Shrimp Paste
114	Lake Waiau (Trailhead), Batch Plant-Upper Hau Kea Parking Lot	13350 2/5	July 20-26, 2008	4069 m	19.82096°N 155.47493°W	Peanut Butter
115	Lake Waiau (Trailhead), Batch Plant-Upper Hau Kea Parking Lot	13350 2/5	July 20-26, 2008	4069 m	19.82096°N 155.47493°W	Sticky
116	Lake Waiau (Trailhead), Batch Plant-Upper Hau Kea Parking Lot	13350 2/5	July 20-26, 2008	4069 m	19.82096°N 155.47493°W	Yellow Pan Trap
117	Batch Plant Parking Lot to Lake Waiau-Upper Hau Kea Parking Lot	13342 3/5	July 20-26, 2008	4067 m	19.82040°N 155.47488°W	Yellow Pan Trap
118	Batch Plant Parking Lot to Lake Waiau-Upper Hau Kea Parking Lot	13342 3/5	July 20-26, 2008	4067 m	19.82040°N 155.47488°W	Peanut Butter
119	Batch Plant Parking Lot to Lake Waiau-Upper Hau Kea Parking Lot	13342 3/5	July 20-26, 2008	4067 m	19.82040°N 155.47488°W	Sticky
120	Batch Plant Parking Lot to Lake Waiau-Upper Hau Kea Parking Lot	13342 3/5	July 20-26, 2008	4067 m	19.82040°N 155.47488°W	Pitfall: Glycol, Shrimp Paste

Table 3 (cont.). Sample locations for alien arthropod sampling for the 2008 field season.

Site No	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
121	Lake Waiau (Trailhead), Batch Plant-Upper Park. Lot	13336 4/5	July 20-26, 2008	4065 m	19.81991°N 155.47527°W	Sticky
122	Lake Waiau (Trailhead), Batch Plant-Upper Park. Lot	13336 4/5	July 20-26, 2008	4065 m	19.81991°N 155.47527°W	Yellow Pan Trap
123	Lake Waiau (Trailhead), Batch Plant-Upper Park. Lot	13336 4/5	July 20-26, 2008	4065 m	19.81991°N 155.47527°W	Peanut Butter
124	Lake Waiau (Trailhead), Batch Plant-Upper Park. Lot	13336 4/5	July 20-26, 2008	4065 m	19.81991°N 155.47527°W	Pitfall: Glycol, Shrimp Paste
125	Batch Plant-Lowest Elevation area near Lake Waiau Trailhead	13297 5/5	July 20-26, 2008	4053 m	19.81934°N 155.47461°W	Sticky
126	Batch Plant-Lowest Elevation area near Lake Waiau Trailhead	13297 5/5	July 20-26, 2008	4065 m	19.81934°N 155.47461°W	Yellow Pan Trap
127	Batch Plant-Lowest Elevation area near Lake Waiau Trailhead	13297 5/5	July 20-26, 2008	4065 m	19.81934°N 155.47461°W	Peanut Butter
128	Batch Plant-Lowest Elevation area near Lake Waiau Trailhead	13297 5/5	July 20-26, 2008	4065 m	19.81934°N 155.47461°W	Pitfall: Glycol, Shrimp Paste
129	Upper Pu'u Hau Kea Parking Lot	13450 SM/CI 1	July 20-26, 2008	4100 m	19.82521°N 155.47733°W	Sticky
130	Upper Pu'u Hau Kea Parking Lot	13450 SM/CI 1	July 20-26, 2008	4100 m	19.82521°N 155.47733°W	Peanut Butter
131	Upper Pu'u Hau Kea Parking Lot	13450 SM/CI 1	July 20-26, 2008	4100 m	19.82521°N 155.47733°W	Yellow Pan Trap
132	Upper Pu'u Hau Kea Parking Lot	13450 SM/CI 1	July 20-26, 2008	4100 m	19.82521°N 155.47733°W	Pitfall: Glycol, Shrimp Paste
133	Upper Pu'u Hau Kea Parking Lot	13383 SM/CI 2	July 20-26, 2008	4079 m	19.82463°N 155.47707°W	Sticky
134	Upper Pu'u Hau Kea Parking Lot	13383 SM/CI 2	July 20-26, 2008	4079 m	19.82463°N 155.47707°W	Peanut Butter
135	Upper Pu'u Hau Kea Parking Lot	13383 SM/CI 2	July 20-26, 2008	4079 m	19.82463°N 155.47707°W	Yellow Pan Trap
136	Upper Pu'u Hau Kea Parking Lot	13383 SM/CI 2	July 20-26, 2008	4079 m	19.82463°N 155.47707°W	Pitfall: Glycol, Shrimp Paste

Table 3 (cont.). Sample locations for alien arthropod sampling for the 2008 field season.

Site No	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
137	Upper Pu'u Hau Kea Parking Lot	13363 SM/CI 3	July 20-26, 2008	4073 m	19.82370°N 155.47688°W	Sticky
138	Upper Pu'u Hau Kea Parking Lot	13363 SM/CI 3	July 20-26, 2008	4073 m	19.82370°N 155.47688°W	Peanut Butter
139	Upper Pu'u Hau Kea Parking Lot	13363 SM/CI 3	July 20-26, 2008	4073 m	19.82370°N 155.47688°W	Pitfall: Glycol, Shrimp Paste
140	Upper Pu'u Hau Kea Parking Lot	13363 SM/CI 3	July 20-26, 2008	4073 m	19.82370°N 155.47688°W	Yellow Pan Trap
141	Upper Pu'u Hau Kea Parking Lot	13346 SM/CI 4	20 July 2008	4068 m	19.82006°N 155.47403°W	Pitfall: Glycol, Shrimp Paste
142	Upper Pu'u Hau Kea Parking Lot	13346 SM/CI 4	20 July 2008	4068 m	19.82006°N 155.47403°W	Peanut Butter
143	Upper Pu'u Hau Kea Parking Lot	13346 SM/CI 4	20 July 2008	4068 m	19.82006°N 155.47403°W	Sticky
144	Upper Pu'u Hau Kea Parking Lot	13346 SM/CI 4	20 July 2008	4068 m	19.82006°N 155.47403°W	Yellow Pan Trap
145	Upper Pu'u Hau Kea Parking Lot	13327 SM/CI 5	20 July 2008	4062 m	19.82281°N 155.47682°W	Pitfall: Glycol, Shrimp Paste
146	Upper Pu'u Hau Kea Parking Lot	13327 SM/CI 5	20 July 2008	4062 m	19.82281°N 155.47682°W	Sticky
147	Upper Pu'u Hau Kea Parking Lot	13327 SM/CI 5	20 July 2008	4062 m	19.82281°N 155.47682°W	Yellow Pan Trap
148	Lake Waiau (did not trap for Wēkiu)	LW 1	20 July 2008	3968 m	19.81129°N 155.47688°W	Yellow Pan Trap
149	Lake Waiau (did not trap for Wēkiu)	LW 1	20 July 2008	3968 m	19.81129°N 155.47688°W	Pitfall: Glycol, Shrimp Paste
150	Lake Waiau (did not trap for Wēkiu)	LW 1	20 July 2008	3968 m	19.81129°N 155.47688°W	Sticky
151	Lake Waiau (did not trap for Wēkiu)	LW 1	20 July 2008	3968 m	19.81129°N 155.47688°W	Peanut Butter
152	VLBA Parking Lot	VLBA 1	July 21-27, 2008	3737 m	19.80168°N 155.45604°W	Peanut Butter

Table 3 (cont.). Sample locations for alien arthropod sampling for the 2008 field season.

Site No	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
153	VLBA Parking Lot	VLBA 1	July 21-27, 2008	3737 m	19.80168°N 155.45604°W	Yellow Pan Trap
154	VLBA Parking Lot	VLBA 1	July 21-27, 2008	3737 m	19.80168°N 155.45604°W	Sticky
155	Keck Observatory 1 Backside	Keck1	July 21-27, 2008	4148 m	19.82930°N 155.47751°W	Sticky
156	Keck Observatory 1 Backside	Keck1	July 21-27, 2008	4148 m	19.82930°N 155.47751°W	Yellow Pan Trap
157	Keck Observatory 1 Backside	Keck1	July 21-27, 2008	4148 m	19.82930°N 155.47751°W	Peanut Butter 2 traps
158	Summit Lunch Room	LR 1	July 21-26, 2008	4223 m	19.82287°N 155.46994°W	2-Sticky
159	Summit Lunch Room	LR 1	July 21-26, 2008	4223 m	19.82287°N 155.46994°W	Pitfall: Glycol, Shrimp Paste
160	Summit Lunch Room	LR 1	July 21-26, 2008	4223 m	19.82287°N 155.46994°W	2 Peanut Butter
161	Summit Lunch Room	LR 1	July 21-26, 2008	4223 m	19.82287°N 155.46994°W	2-Yellow Pan Trap
162	Gemini Scope: Disturbed substrate next to Gemini	G-1	21 July 2008	4219 m	19.82368°N 155.46921°W	Sticky: (Outside of trashcan)
163	Gemini Scope: Disturbed substrate next to Gemini	G-1	21 July 2008	4219 m	19.82368°N 155.46921°W	Sticky: (Walkway area)
164	Gemini Scope: Disturbed substrate next to Gemini	G-1	21 July 2008	4219 m	19.82368°N 155.46921°W	Yellow Pan trap
165	Gemini Scope: Disturbed substrate next to Gemini	G-1	21 July 2008	4219 m	19.82368°N 155.46921°W	Peanut Butter
166	John Burns Parking Lot	Burns Parking Lot 1A	July 22-25, 2008	3634 m	19.79663°N 155.46121°W	Sticky
167	John Burns Parking Lot	Burns Parking Lot 1A	July 22-25, 2008	3634 m	19.79663°N 155.46121°W	Yellow Pan Trap

Table 3 (cont.). Sample locations for alien arthropod sampling for the 2008 field season.

Site No.	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
168	John Burns Parking Lot	Burns Parking Lot 1A	July 22-25, 2008	3634 m	19.79663°N 155.46121°W	Peanut Butter
169	John Burns Parking Lot	Burns Parking Lot 1A	July 22-25, 2008	3634 m	19.79663°N 155.46121°W	Pitfall: Glycol, Shrimp Paste
170	30 m Proposed Scope-Upper	30m-1A	July 22-26, 2008	4076 m	19.83148°N 155.48262°W	Peanut Butter
171	30 m Proposed Scope-Upper	30m-1A	July 22-26, 2008	4076 m	19.83148°N 155.48262°W	Pitfall: Glycol, Shrimp Paste
172	30 m Proposed Scope-Upper	30m-1A	July 22-26, 2008	4076 m	19.83148°N 155.48262°W	Sticky
173	30 m Proposed Scope-Upper	30m-1A	July 22-26, 2008	4076 m	19.83148°N 155.48262°W	Yellow Pan Trap
174	30 m Proposed Scope-Lower	2 Lower 30 m	July 22-26, 2008	4046 m	19.83016°N 155.48047°W	Pitfall: Glycol, Shrimp Paste
175	30 m Proposed Scope-Lower	2 Lower 30 m	July 22-26, 2008	4046 m	19.83016°N 155.48047°W	Sticky
176	30 m Proposed Scope-Lower	2 Lower 30 m	July 22-26, 2008	4046 m	19.83016°N 155.48047°W	Yellow Pan Trap
177	30 m Proposed Scope-Lower	2 Lower 30 m	July 22-26, 2008	4046 m	19.83016°N 155.48047°W	Peanut Butter
178	Burns Cone Base	Burns 1B	July 22-27, 2008	3611 m	19.79351°N 155.45950°W	Pitfall: Glycol, Shrimp Paste
179	Burns Cone Base	Burns 1B	July 22-27, 2008	3611 m	19.79351°N 155.45950°W	Peanut Butter
180	Burns Cone Base	Burns 1B	July 22-27, 2008	3611 m	19.79351°N 155.45950°W	Yellow Pan Trap
181	Burns Cone Base	Burns 1B	July 22-27, 2008	3611 m	19.79351°N 155.45950°W	Sticky
182	NASA	1	July 23-26, 2008	4181 m	19.82637°N 155.47214°W	Pitfall, Glycol

Table 3 (cont.). Sample locations for alien arthropod sampling for the 2008 field season.

Site No.	Locality	Trap #	2008 Date Set	Elevation	GPS	Trap Type
183	NASA	1	July 23-26, 2008	4181 m	19.82637°N 155.47214°W	Peanut butter
184	NASA	1	July 23-26, 2008	4181 m	19.82637°N 155.47214°W	Yellow Pan Trap
185	NASA	1	July 23-26, 2008	4181 m	19.82637°N 155.47214°W	Sticky

Table 4. Shrimp pitfall trap GPS locations (WGS 84) for wēkiu bug surveys conducted in July 2008 (altitudes from taken from altimeter, some variation may occur).

SAMPLE NUMBER	Cinder Cone	2008 Sample Date	Trap #	Trap Elevation	GPS Coordinates (WGS 84)	Trap Type
186	Pu‘u Hau Kea	July 23, 2008	Hau Kea 1A	4122 m	19.81639°N 155.47580°W	Shrimp
187	Pu‘u Hau Kea	July 26, 2008	Hau Kea 1A	4122 m	19.81639°N 155.47580°W	Shrimp
188	Pu‘u Hau Kea	July 23, 2008	Hau Kea 2A	4129 m	19.81660°N 155.47606°W	Shrimp
189	Pu‘u Hau Kea	July 26, 2008	Hau Kea 2A	4129 m	19.81660°N 155.47606°W	Shrimp
190	Pu‘u Hau Kea	July 23, 2008	Hau Kea 3A	4126 m	19.81698°N 155.47617°W	Shrimp
191	Pu‘u Hau Kea	July 26, 2008	Hau Kea 3A	4126 m	19.81698°N 155.47617°W	Shrimp
192	Pu‘u Hau Kea	July 23, 2008	Hau Kea 4A	4126 m	19.81729°N 155.47620°W	Shrimp
193	Pu‘u Hau Kea	July 26, 2008	Hau Kea 4A	4126 m	19.81729°N 155.47620°W	Shrimp
194	Pu‘u Hau Kea	July 23, 2008	Hau Kea 5A	4130 m	19.81758°N 155.47606°W	Shrimp
195	Pu‘u Hau Kea	July 26, 2008	Hau Kea 5A	4130 m	19.81758°N 155.47606°W	Shrimp
196	Pu‘u Hau Kea	July 23, 2008	1 Hau Kea E	4111 m	19.81339°N 155.47299°W	Shrimp
197	Pu‘u Hau Kea	July 26, 2008	1 Hau Kea E	4111 m	19.81339°N 155.47299°W	Shrimp
198	Pu‘u Hau Kea	July 23, 2008	2 Hau Kea E	4116 m	19.81359°N 155.47319°W	Shrimp
199	Pu‘u Hau Kea	July 26, 2008	2 Hau Kea E	4116 m	19.81359°N 155.47319°W	Shrimp
200	Pu‘u Hau Kea	July 23, 2008	3 Hau Kea E	4119 m	19.81382°N 155.47328°W	Shrimp
201	Pu‘u Hau Kea	July 26, 2008	3 Hau Kea E	4119 m	19.81382°N 155.47328°W	Shrimp
202	Pu‘u Hau Kea	July 23, 2008	4 Hau Kea E	4118 m	19.81420°N 155.47327°W	Shrimp
203	Pu‘u Hau Kea	July 26, 2008	4 Hau Kea E	4118 m	19.81420°N 155.47327°W	Shrimp
204	Pu‘u Hau Kea	July 23, 2008	5 Hau Kea E	4123 m	19.81454°N 155.47311°W	Shrimp
205	Pu‘u Hau Kea	July 26, 2008	5 Hau Kea E	4123 m	19.81454°N 155.47311°W	Shrimp
206	Pu‘u S. of VLBA	July 21-24, 2008	S. VLBA 1	3775 m	19.79980°N 155.45613°W	Shrimp
207	Pu‘u S. of VLBA	July 21-24, 2008	S. VLBA 2	3814 m	19.79912°N 155.45572°W	Shrimp

Table 4 (cont.). Shrimp pitfall trap GPS locations (WGS 84) for wēkiu bug surveys conducted in July 2008 (altitudes from taken from altimeter, some variation may occur).

SAMPLE NUMBER	Cinder Cone	2008 Capture Date	Trap #	Elevation	GPS Coordinates (WGS 84)	Trap Type
208	Pu‘u S. of VLBA	July 21-24, 2008	S. VLBA 3	3814 m	19.79909 N 155.45551°W	Shrimp
209	Pu‘u S. of VLBA	July 21-24, 2008	S. VLBA 4	3814 m	19.79898 N 155.45517°W	Shrimp
210	Pu‘u S. of VLBA	July 21-24, 2008	S. VLBA 5	3806 m	19.79847 N 155.45506°W	Shrimp
211	Pu‘u N. of VLBA	July 21-24, 2008	N/VLBA 1	3807 m	19.80592 N 155.46086°W	Shrimp
212	Pu‘u N. of VLBA	July 21-24, 2008	N/VLBA 2	3857 m	19.80632°N 155.46164°W	Shrimp
213	Pu‘u N. of VLBA	July 21-24, 2008	N/VLBA 3	3859 m	19.80647°N 155.46167°W	Shrimp
214	Pu‘u N. of VLBA	July 21-24, 2008	N/VLBA 4	3852 m	19.80674°N 155.46182°W	Shrimp
215	Pu‘u N. of VLBA	July 21-24, 2008	N/VLBA 5	3862 m	19.80680°N 155.46208°W	Shrimp
216	Pu‘u Wēkiu (Bottom of Pu‘u Wēkiu)	July 22-25, 2008	Pu‘u Wēkiu 1A	4142 m	19.82259°N 155.47234°W	Shrimp
217	Pu‘u Wēkiu	July 22-25, 2008	Pu‘u Wēkiu 2A	4173 m	19.82330°N 155.47229°W	Shrimp
218	Pu‘u Wēkiu (Top rim)	July 22-25, 2008	Pu‘u Wēkiu RS-1	4169 m	19.81855°N 155.46988°W	Shrimp
219	Pu‘u Wēkiu (Inside Pu‘u Wēkiu crater above weather station)	July 22-25, 2008	Pu‘u Wēkiu RS-2	4167 m	19.81874°N 155.46965°W	Shrimp
220	Pu‘u Wēkiu (Near weather station)	July 22-25, 2008	Pu‘u Wēkiu RS-3	4157 m	19.81910°N 155.46948°W	Shrimp
221	Pu‘u Hau Oki (Near Keck)	July 21-24, 2008	Hau Oki 1	4173 m	19.82582°N 155.47520°W	Shrimp
222	Pu‘u Hau Oki	July 21-24, 2008	Hau Oki 2	4162 m	19.82605°N 155.47525°W	Shrimp
223	Pu‘u Hau Oki	July 21-24, 2008	Hau Oki 3	4159 m	19.82629°N 155.47527°W	Shrimp
224	Pu‘u Hau Oki	July 21-24, 2008	Hau Oki 4	4157 m	19.82645°N 155.47525°W	Shrimp
225	Pu‘u Hau Oki (Lower)	July 21-24, 2008	Hau Oki 5	4150 m	19.82661°N 155.47551°W	Shrimp

Table 5. Wēkiu bug capture data from surveyed Mauna Kea cinder cones using visual collections, shrimp pitfall, and ethylene glycol pitfall traps in June 2007.

Cinder Cone	2007 Capture Date	Trap #	Elevation	GPS Coordinates	Wēkiu #'s	Trap Type
Pu'u Hau Kea	June 8, 2007	1-1	4014 m	19.81622°N 155.47388°W	2	Shrimp
Pu'u Hau Kea	June 8, 2007	2	4042 m	19.81572°N 155.47350°W	61	Shrimp
Pu'u Hau Kea	June 8, 2007	3	4087 m	19.81480°N 155.47304°W	9	Shrimp
Pu'u Hau Kea	June 5, 2007	4	4084 m	19.81489°N 155.47247°W	50	Shrimp
Pu'u Hau Kea	June 5, 2007	5	4090 m	19.81448°N 155.47321°W	18	Shrimp
Pu'u Hau Kea	June 8, 2007	6	4090 m	19.81407°N 155.47345°W	10	Shrimp
Pu'u Wēkiu	June 7, 2007	T1	4188 m	19.82273°N 155.46902°W	9	Shrimp
Pu'u Wēkiu	June 1-7, 2007	T5B	4185 m	19.81862°N 155.46933°W	58	Shrimp
Pu'u Wēkiu	June 7, 2007	T6	4179 m	19.82238°N 155.46922°W	1	Shrimp
Pu'u Wēkiu	June 7, 2007	T6B	4211 m	19.8223564°N 155.46922°W	21	Shrimp
Pu'u Wēkiu	June 7, 2007	T7	4164 m	19.82192°N 155.46880°W	30	Shrimp
Pu'u Wēkiu	June 7, 2007	T8-1	4173 m	19.82142°N 155.46848°W	23	Shrimp
Pu'u Wēkiu	June 7, 2007	T9-1	4,133 m	19.82104°N 155.46840°W	1	Shrimp
Pu'u Wēkiu	June 7, 2007	T11-1	4,134 m	19.82069°N 155.47105°W	1	Shrimp
Pu'u Wēkiu	June 7, 2007	T20	4170 m	19.82273°N 155.46902°W	21	Shrimp
Pu'u Wēkiu	June 7, 2007	T 21	4185 m	19.82064°N 155.46878°W	27	Shrimp
Pu'u S. of VLBA	June 9, 2007	S1	3746 m	19.80001°N 155.45598°W	2	Shrimp
Pu'u S. of VLBA	June 9, 2007	S2	3761 m	19.79964°N 155.45605°W	3	Shrimp
Pu'u S. of VLBA	June 9, 2007	S3	3780 m	19.79921°N 155.45590°W	2	Shrimp
Pu'u S of VLBA	June 9, 2007	S5	3786 m	19.79904°N 155.45512°W	4	Shrimp
Pu'u N. of VLBA	June 9, 2007	N1	3752 m	19.80234°N 155.45738°W	1	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T1	4168 m	19.82720°N 155.47475°W	35	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T2	4158 m	19.82722°N 155.47493°W	6	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T3	4147 m	19.82707°N 155.47507°W	15	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T4	4159 m	19.82693°N 155.47502°W	40	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T5	4149 m	19.82720°N 155.47523°W	8	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T6B-1	4170 m	19.82590°N 155.47539°W	3	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T7B	4174 m	19.82614°N 155.47519°W	38	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T8B-1	4161 m	19.82628°N 155.47527°W	8	Shrimp
Pu'u Hau Oki	June 1-7, 2007	T9B	4158 m	19.82645°N 155.47527°W	30	Shrimp
June 2007 Total					537	

Table 6. Wēkiu bug capture data from surveyed Mauna Kea cinder cones using shrimp pitfall traps in July 2008.

SAMPLE NUMBER	Cinder Cone	2008 Capture Date	Trap #	Elevation	GPS Coordinates (WGS 84)	Wēkiu #'s	Trap Type
226	Pu'u Hau Kea	July 23, 2008	Hau Kea 1A	4122 m	19.81639°N 155.47580°W	4	Shrimp
227	Pu'u Hau Kea	July 26, 2008	Hau Kea 1A	4122 m	19.81639°N 155.47580°W	1	Shrimp
228	Pu'u Hau Kea	July 23, 2008	Hau Kea 2A	4129 m	19.81660°N 155.47606°W	1	Shrimp
229	Pu'u Hau Kea	July 26, 2008	Hau Kea 2A	4129 m	19.81660°N 155.47606°W	1	Shrimp
230	Pu'u Hau Kea	July 23, 2008	Hau Kea 3A	4126 m	19.81698°N 155.47617°W	0	Shrimp
231	Pu'u Hau Kea	July 26, 2008	Hau Kea 3A	4126 m	19.81698°N 155.47617°W	2	Shrimp
232	Pu'u Hau Kea	July 23, 2008	Hau Kea 4A	4126 m	19.81729°N 155.47620°W	0	Shrimp
233	Pu'u Hau Kea	July 26, 2008	Hau Kea 4A	4126 m	19.81729°N 155.47620°W	1	Shrimp
234	Pu'u Hau Kea	July 23, 2008	Hau Kea 5A	4130 m	19.81758°N 155.47606°W	0	Shrimp
235	Pu'u Hau Kea	July 26, 2008	Hau Kea 5A	4130 m	19.81758°N 155.47606°W	1	Shrimp
236	Pu'u Hau Kea	July 23, 2008	1 Hau Kea E	4111 m	19.81339°N 155.47299°W	7	Shrimp
237	Pu'u Hau Kea	July 26, 2008	1 Hau Kea E	4111 m	19.81339°N 155.47299°W	3	Shrimp
238	Pu'u Hau Kea	July 23, 2008	2 Hau Kea E	4116 m	19.81359°N 155.47319°W	1	Shrimp
239	Pu'u Hau Kea	July 26, 2008	2 Hau Kea E	4116 m	19.81359°N 155.47319°W	2	Shrimp
240	Pu'u Hau Kea	July 23, 2008	3 Hau Kea E	4119 m	19.81382°N 155.47328°W	5	Shrimp
241	Pu'u Hau Kea	July 26, 2008	3 Hau Kea E	4119 m	19.81382°N 155.47328°W	1	Shrimp
242	Pu'u Hau Kea	July 23, 2008	4 Hau Kea E	4118 m	19.81420°N 155.47327°W	8	Shrimp
243	Pu'u Hau Kea	July 26, 2008	4 Hau Kea E	4118 m	19.81420°N 155.47327°W	5	Shrimp
244	Pu'u Hau Kea	July 23, 2008	5 Hau Kea E	4123 m	19.81454°N 155.47311°W	0	Shrimp
245	Pu'u Hau Kea	July 26, 2008	5 Hau Kea E	4123 m	19.81454°N 155.47311°W	0	Shrimp
246	Pu'u S. of VLBA	July 21-24, 2008	S. VLBA 1	3775 m	19.79980°N 155.45613°W	7	Shrimp
247	Pu'u S. of VLBA	July 21-24, 2008	S. VLBA 2	3814 m	19.79912°N 155.45572°W	0	Shrimp
248	Pu'u S. of VLBA	July 21-24, 2008	S. VLBA 3	3814 m	19.79909°N 155.45551°W	2	Shrimp
249	Pu'u S. of VLBA	July 21-24, 2008	S.VLBA 4	3814 m	19.79898°N 155.45517°W	0	Shrimp

Table 6 (cont.). Wēkiu bug capture data from surveyed Mauna Kea cinder cones using shrimp pitfall traps in July 2008.

SAMPLE NUMBER	Cinder Cone	2008 Capture Date	Trap #	Elevation	GPS Coordinates (WGS 84)	Wēkiu #'s	Trap Type
250	Pu'u S. of VLBA	July 21-24, 2008	S.VLBA 5	3806 m	19.79847°N 155.45506°W	0	Shrimp
251	Pu'u N. of VLBA	July 21-24, 2008	N/VLBA 1	3807 m	19.80592°N 155.46086°W	0	Shrimp
252	Pu'u N. of VLBA	July 21-24, 2008	N/VLBA 2	3857 m	19.80632°N 155.46164°W	0	Shrimp
253	Pu'u N. of VLBA	July 21-24, 2008	N/VLBA 3	3859 m	19.80647°N 155.46167 W	0	Shrimp
254	Pu'u N. of VLBA	July 21-24, 2008	N/VLBA 4	3852 m	19.80674°N 155.46182 W	0	Shrimp
255	Pu'u N. of VLBA	July 21-24, 2008	N/VLBA 5	3862 m	19.80680°N 155.46208 W	0	Shrimp
256	Pu'u Wēkiu (Bottom of Pu'u Wēkiu)	July 22-25, 2008	Pu'u Wēkiu 1A	4142 m	19.82259°N 155.47234 W	1	Shrimp
257	Pu'u Wēkiu	July 22-25, 2008	Pu'u Wēkiu 2A	4173 m	19.82330°N 155.47229 W	0	Shrimp
258	Pu'u Wēkiu (Top rim)	July 22-25, 2008	Pu'u Wēkiu RS-1	4169 m	19.81855°N 155.46988 W	0	Shrimp
259	Pu'u Wēkiu (Inside Pu'u Wēkiu crater above weather station)	July 22-25, 2008	Pu'u Wēkiu RS-2	4167 m	19.81874°N 155.46965 W	0	Shrimp
260	Pu'u Wēkiu (Near weather station)	July 22-25, 2008	Pu'u Wēkiu RS-3	4157 m	19.81910°N 155.46948 W	3	Shrimp
261	Pu'u Hau Oki (Near Keck)	July 21-24, 2008	Hau Oki 1	4173 m	19.82582°N 155.47520 W	0	Shrimp
262	Pu'u Hau Oki	July 21-24, 2008	Hau Oki 2	4162 m	19.82605°N 155.47525 W	3	Shrimp
263	Pu'u Hau Oki	July 21-24, 2008	Hau Oki 3	4159 m	19.82629°N 155.47527 W	0	Shrimp
264	Pu'u Hau Oki	July 21-24, 2008	Hau Oki 4	4157 m	19.82645°N 155.47525 W	2	Shrimp
265	Pu'u Hau Oki (Lower)	July 21-24, 2008	Hau Oki 5	4150 m	19.82661°N 155.47551 W	9	Shrimp
	Totals (2008)					70	

Table 7. Summary of 2007 sample effort and wēkiu bug captures from surveyed Mauna Kea cinder cones using both shrimp pitfall and ethylene glycol pitfall (Lake Waiau only) traps in June 2007.

Cinder Cone	Highest Elevation	Total Traps	Wēkiu bugs in traps	Wēkiu bugs visual observation only ¹	Trap Dates	Total Trap Days ²
Pu‘u Hau Kea	4,131 m	13	217	0	2–8 June	78
Pu‘u Hau Oki	4,174 m	9	183	0	1–7 June	54
Pu‘u Wēkiu	4,205 m	10	125	0	1–7 June	60
Pu‘u N. VLBA	3,852 m	5	1	0	3–9 June	30
Pu‘u S. VLBA	3,809 m	5	11	0	3–9 June	30
Totals		42	537	0		252

¹Number of wēkiu bugs hand collected around snowbanks and near traps during 20-30 minute trials by 2-3 observers, but not collected in traps. ²Trap days = total nights x total traps per cinder cone.

Table 8. Summary of 2008 sample effort and wēkiu bug captures from surveyed Mauna Kea cinder cones using both shrimp pitfall traps in July 2008.

Cinder Cone	Highest Elevation	Total Traps	Wēkiu bugs in traps	Wēkiu bugs visual observation only ¹	Trap Dates	Total Trap Days ²
Pu‘u Hau Kea	4,131 m	10	43	0	20–26 July	60
Pu‘u Hau Oki	4,174 m	5	14	0	21–24 July	15
Pu‘u Wēkiu	4,205 m	5	4	0	22–25 July	15
Pu‘u N. VLBA	3,852 m	5	0	0	21–25 July	15
Pu‘u S. VLBA	3,809 m	5	9	0	21–25 July	15
Totals		30	70	0		120

¹Number of wēkiu bugs hand collected around snowbanks and near traps during 20-30 minute trials by 2-3 observers, but not collected in traps. ²Trap days = total nights x total traps per cinder cone.

Table 9. Summary of wēkiu bugs captured at the Pu‘u Hau Kea (within the Natural Area Reserve) cinder cone in Bishop Museum related studies since 2001. Data includes using a combination of glycol and shrimp pitfall data for all years except 2007 and 2008.

Year and Month when Trapping Occurred	Total Wēkiu bugs	Trap Days	Catch Corrected for Effort (Bugs/Trap Day)
2001 (Polhemus 2001) ¹	473	40	11.8
2002 (Sept)	13	48	0.27
2004 (July)	0	90	0
2005 (April/May)	20	144	0.14
2006 (April/May)	56	80	0.7
2007 (June)	217	78	2.8
2008 (July)	43	60	0.7
	822	540	Avg = 2.3

¹Data from Polhemus (2001) was data from glycol traps only.

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Table 10. Temperature/Relative Humidity data loggers on the Mauna Kea installed in December 2004 or June 2005, and pulled in July 2008. Surface loggers at 0 cm, subsurface at 26 cm depth. * = not working

Date First Installed	#	Dec 2004	Logger # (June 05)	Log # (Dec 05) – Pulled Oct. 2006	Replacement Logger # (Oct 06)	Date Replacement Logger Pulled	Logger Placement	Elevation	Locality	GPS Coordinates (WGS 84)
14 Dec 2004	1	789564	789553	not replaced	792717	27 Jul 2008	surface	3,902 m	Hau Kea (trail to Waiau)	19.81296°N 155.47545°W
3 Oct 2006	2	789564	defective, none	not replaced	792692	27 Jul 2008	surface	3,950 m	Pu'u Hau Kea (Keek side)	19.81615°N 155.47391°W
3 Oct 2006	3	792689	defective, none	not replaced	789544	27 Jul 2008	subsurface	3,950 m	Pu'u Hau Kea (Keek side)	19.81615°N 155.47391°W
14 Dec 2004	4		789559	792703	789552	27 Jul 2008	surface	4,058 m	Pu'u Hau Kea	19.81575°N 155.47351°W
14 Dec 2004	5		789545	789546	789565	27 Jul 2008	subsurface	4,058 m	Pu'u Hau Kea	19.81575°N 155.47351°W
14 Dec 2004	6	792737	754788	792702	789547	27 Jul 2008	surface	4,096 m	Pu'u Hau Kea	19.81496°N 155.47305°W
14 Dec 2004	7	792703	789561	792710*	792680	27 Jul 2008	subsurface	4,096 m	Pu'u Hau Kea	19.81496°N 155.47305°W
14 Dec 2004	8	792728	792694	792698	792728	27 Jul 2008	surface	4,105 m	Pu'u Hau Kea	19.81443°N 155.47275°W
14 Dec 2004	9	792691	754792	792708	792689	27 Jul 2008	subsurface	4,105 m	Pu'u Hau Kea	19.81443°N 155.47275°W
14 Dec 2004	10	792698	789549	792714	792694	27 Jul 2008	surface	4,061 m	Pu'u Hau Kea (crater bottom)	19.81413°N 155.47243°W
14 Dec 2004	11	792709	789562	754789	792723	27 Jul 2008	subsurface	4,061 m	Pu'u Hau Kea (crater bottom)	19.81413°N 155.47243°W
14 Dec 2004	12	792695	789544	792731	792741	27 Jul 2008	surface ¹	4,081 m	Pu'u Hau Kea	19.81342°N 155.47214°W
14 Dec 2004	13	792727	754787	792709	789562	27 Jul 2008	subsurface	4,081 m	Pu'u Hau Kea	19.81342°N 155.47214°W
14 Dec 2004	14	792735	754785	792738	789545	27 Jul 2008	surface	4,126 m	Pu'u Hau Kea (Hilo rim side)	19.81331°N 155.47206°W
14 Dec 2004	15	792688	792712	792732	789559	27 Jul 2008	subsurface	4,126 m	Pu'u Hau Kea	19.81331°N 155.47206°W
14 Dec 2004	16	792710	789552	792713	792701	27 Jul 2008	surface	4,096 m	Pu'u Hau Kea	19.81269°N 155.47188°W
14 Dec 2004	17	792715	792739	792684	754786	27 Jul 2008	subsurface	4,096 m	Pu'u Hau Kea	19.81269°N 155.47188°W
14 Dec 2004	18	792723	789565	792688	789558	27 Jul 2008	surface	4,006 m	Pu'u Hau Kea (Hilo side)	19.81112°N 155.47139°W
14 Dec 2004	19	792707	792706	792687	789561	27 Jul 2008	subsurface	4,006 m	Pu'u Hau Kea (Hilo side)	19.81112°N 155.47139°W
7 May 2005	20		792680	789561	not recorded	25 Jul 2008	surface	3,989 m	Pu'u Lilinoe	19.81008°N 155.45908°W

Table 10 (cont.). Temperature/Relative Humidity data loggers on the Mauna Kea installed in December 2004 or June 2005, and pulled in July 2008. Surface loggers at 0 cm, subsurface at 26 cm depth. * = not working

Date First Installed	#	Logger # (Dec 04)	Logger # (June 05)	Logger # (Dec 05) – Pulled Oct. 2006	Replacement Logger # (Oct 06)	Date Replacement Logger Pulled	Logger Placement	Elevation	Locality	GPS Coordinates (WGS 84)
7 May 2005	21		792705	789549	792712	25 Jul 2008	subsurface	3,989 m	Pu'u Lilinoe	19.81008°N 155.45908°W
15 Dec 2005	22		792739	792694	789560	25 Jul 2008	surface	3,843 m	Pu'u Lilinoe	19.80664°N 155.45836°W
15 Dec 2005	23		792694	792739	792720	25 Jul 2008	surface	3,843 m	Pu'u Lilinoe	19.80664°N 155.45836°W
4 June 2005	24	792690	754791	792740	792715	21 Jul 2008?	surface	4,143 m	Pu'u Hau Oki	19.82578°N 155.47539°W
4 June 2005	25	792686	789557	792717	792734	21 Jul 2008?	subsurface	4,143 m	Pu'u Hau Oki	19.82578°N 155.47539°W
4 June 2005	26	792702	729724	792723	792706	24 Jul 2008	surface	4,139 m	Pu'u Hau Oki	19.82721°N 155.47528°W
4 June 2005	27	#7	792693	792686	792724	24 Jul 2008	subsurface	4,139 m	Pu'u Hau Oki	19.82721°N 155.47528°W
4 June 2005	28	792734	789547	754786	792743	24 Jul 2008	surface	4,097 m	Poi Bowl	19.82329°N 155.47491°W
4 June 2005	29	792731	789554	789558	792735 ¹	24 Jul 2008	surface	4,105 m	Poi Bowl	19.82433°N 155.47307°W
4 June 2005	30	792721	792741	792701	789543	24 Jul 2008	surface	4,167 m	Poi Bowl	19.82543°N 155.47256°W
15 Dec 2005	31	792744	792691 ²	792691	792742	23 Jul 2008	surface	4,009 m	Pu'u Pohaku	19.82548°N 155.49011°W
15 Dec 2005	32	792720	792690 ²	792690	754792	23 Jul 2008	subsurface	4,009 m	Pu'u Pohaku	19.82548°N 155.49011°W
15 Dec 2005	33	792742	792736 ²	792736	792684	23 Jul 2008	surface	4,055 m	Pu'u Pohaku	19.82434°N 155.49211°W
15 Dec 2005	34	792684	792730 ²	792730	792688	23 Jul 2008	subsurface	4,055 m	Pu'u Pohaku	19.82434°N 155.49211°W
15 Dec 2005	35		754790 ²	754790	792731	23 Jul 2008	surface	3,914 m	Horseshoe Crater	19.82953°N 155.50050°W
15 Dec 2005	36		754790 ²	754790	789546	23 Jul 2008	surface	3,914 m	Horseshoe Crater	19.82953°N 155.50050°W
15 Dec 2005	37		789550	789550	792732	23 Jul 2008	surface	3,924 m	Horseshoe Crater	19.83063°N 155.49815°W
15 Dec 2005	38		792695	792695	792738	23 Jul 2008	surface	3,924 m	Horseshoe Crater	19.83063°N 155.49815°W
13 Dec 2005	39		792697	792697	754788	27 Jul 2008	subsurface	4,154 m	Pu'u Poliahu	19.82298°N 155.48096°W
17 Dec 2004	40	#4 (754793)	792742	792742	792705	27 Jul 2008	surface	4,154 m	Pu'u Poliahu	19.82298°N 155.48096°W
13 Dec 2005	41		792728	792728	789554	27 Jul 2008	subsurface	4,175 m	Pu'u Poliahu	19.82101°N 155.48149°W
13 Dec 2005	42		792689	792689	789566	27 Jul 2008	surface	4,175 m	Pu'u Poliahu	19.82101°N 155.48149°W
15 Dec 2005	43		n/a	754792	792693	21 July 2008	surface	3,840 m	Pu'u North of VLBA	19.80324°N 155.45889°W
15 Dec 2005	44		n/a	754791	792733	21 July 2008	surface	3,850 m	Pu'u North of VLBA	19.80372°N 155.45930°W

Table 10 (cont.). Temperature/Relative Humidity data loggers on the Mauna Kea installed in December 2004 or June 2005, and pulled in July 2008. Surface loggers at 0 cm, subsurface at 26 cm depth. * = not working

14 Dec 2005	45			792744	754787	24 Jul 2008	surface	3,663 m	Pu'u by J. Burns road sign	19.79351°N 155.46120°W
14 Dec 2005	46		n/a	792721	792697	24 Jul 2008	surface	3,702 m	Pu'u by J. Burns road sign	19.79250°N 155.46034°W
14 Dec 2005	47		n/a	754793	792702	24 Jul 2008	surface	3,700 m	Pu'u by J. Burns road sign	19.79170°N 155.45973°W
16 Dec. 2004		792692	not replaced				subsurface	3,963 m	Pu'u Mahoe	19.83554°N 155.46239°W

APPENDIX C: ALIEN ARTHROPOD TABLES 2007-2008

Table 11. Alien arthropod species list for 2007 sampling on Mauna Kea.

TAXA	status	Resident/Aeolian	2007 Site Number
ACARI			
Genus (?) species (?)	end ?	Resident ?	12
ARANEAE			
Linyphiidae			
more than 1 species	end/adv ?	Resident	24
Lycosidae			
<i>Lycosa</i> sp.	end	Resident	2, 27, 37
COLLEMBOLA			
Entomobryidae			
more than 1 species	end ?	Resident ?	12
COLEOPTERA			
Cleridae			
<i>Necrobia rufipes</i> (DeGeer)	adv	Aeolian	22
Coccinellidae			
<i>Coccinella septempunctata</i> L.	pur	Aeolian	2
<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian	36, 38
Dyticidae			
<i>Rhantus pacificus</i>	end	Resident	6
Hydrophilidae			
?Genus ?species	pur ?	Aeolian	24
Staphylinidae			
several species	end ?	Aeolian	24
DIPTERA			
Calliphoridae			
<i>Calliphora vomitoria</i> (Linnaeus)	adv	Aeolian ?	10, 15, 15, 19, 25, 31, 32, 34, 36, 38, 41, 47
Ceratopogonidae			
<i>Forcipomyia</i> sp.	end	Aeolian	31, 50
Chironomidae	end ?	Aeolian	6, 14
Drosophilidae			
<i>Drosophila</i> sp.	adv	Aeolian	50

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Ephydriidae					
<i>Hydrellia tritici</i> Coquillett		adv	Aeolian	10, 16, 48, 50	
sp. 1		adv ?	Aeolian	50	
Muscidae					
<i>Atherogona orientalis</i> Schiner		adv	Aeolian	1, 2, 10, 16, 18, 19, 25, 30, 32, 38, 44, 47, 50	
Muscoidea (indet.)		adv ?	Aeolian	2, 10, 16, 32, 37	
Phoridae					
several species		adv ?	Aeolian	2, 14, 22	
Sarcophagidae					
several species		adv	Aeolian	2, 10, 16, 18, 19, 22, 30, 31, 32, 37, 41, 42, 47, 48, 50	
Sciaridae					
? <i>Bradysia</i> sp. 1		end ?	Aeolian	22, 50	
<i>Sciara</i> sp.		adv ?	Aeolian	47	
Sepsidae					
<i>Sepsis thoracica</i>					
(Robineau-Devoidy)		adv	Aeolian	1, 10, 22, 31, 38, 48, 50	
Sphaeroceridae					
<i>Copromyza equina</i> (Fallen)		adv	Aeolian	6	
<i>Leptocera</i> (several species)		adv ?	Aeolian	6, 14, 20, 22, 48	
Syrphidae					
<i>Allograpta</i> sp.		pur	Aeolian	2, 14, 16, 19, 22, 31, 32, 38, 42, 47	
Tachinidae					
<i>Gonia longipulvilli</i> Tothill		adv	Aeolian	41, 42, 46, 48	
<i>Phasioormia pallida</i> Townsend		adv	Aeolian	50	
?Genus ?species		adv	Aeolian	32, 42, 50	
HETEROPTERA					
Lygaeidae					
<i>Geocoris pallens</i> Stal		adv	Resident	2, 49	
<i>Neacoryphus bicrucis</i> Say		adv	Aeolian	24	
<i>Nysius wekiticola</i>				see Report	
Ashlock & Gagne		end	Resident		
<i>Nysius</i> sp. 1 = phytophagus		end	Aeolian	10, 37	
<i>Nysius</i> sp. 2 = phytophagus		end	Aeolian	1, 50	

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HOMOPTERA				
Aphidae				
<i>Aphis</i> sp.	adv	Aeolian	47, 50	
Cicadellidae				
?Genus ?species	adv ?	Aeolian	18	
Psyllidae				
Genus (?) species (?)	adv ?	Aeolian	2, 6, 12, 22, 24, 25, 30, 31, 32, 34, 36, 37, 42	
HYMENOPTERA				
Apidae				
<i>Apis mellifera</i>	adv	Aeolian	1, 2, 10, 25, 32, 47, 50, 51	
Braconidae				
<i>Apanteles</i> sp. 1	pur ?	Aeolian ?	1, 2, 7, 10, 17, 24, 30, 38, 47, 50	
<i>Bracon</i> sp. 1	pur ?	Aeolian ?	14, 50	
Colletidae				
<i>Hyleaus</i> sp. spp.	end	Aeolian	1, 5, 4, 32, 47, 50	
Undetermined micro-hymenoptera	adv.	Aeolian	16, 24, 30, 42, 48, 50	
Ichneumonidae				
<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian	2, 7, 19, 25, 30, 31, 38	
<i>Ichneumon cupitus</i> Cresson	adv	Aeolian	2, 5, 47	
?Genus ?species	adv ?	Aeolian	3	
Vespidae				
<i>Polistes olivaceus</i>	adv	Aeolian	1	
LEPIDOPTERA				
Noctuidae				
<i>Agrotis</i> sp.	end	Resident	16, 48	
Oecophoridae				
<i>Agonopterix ulicetella</i>	pur	Aeolian	1, 44, 47	
Thysanoptera				
Thripidae				
<i>Thrips</i>	end ?	Aeolian	3	

Table 12. Alien arthropod species list for 2008 sampling on Mauna Kea.

TAXA	status	Resident/Aeolian	2008 sites
ACARI			
Genus (?) species (?)	end ?	Resident ?	None
ARANEAE			
Gnaphosidae	adv	Resident	078, 083, det. FGH.
<i>Urozeleles rusticus</i> (L. Koch)			
Linyphiidae	end/adv ?	Resident	135, 140, 220,
Lycosidae			
<i>Lycosa</i> sp.	end	Resident	110, 136 det. FGH, 145, 171, 174, 1 to FGH, 191,
nr. Clubionidae specimens damaged	adv	Resident ?	094, det. FGH.
Genus (?) species (?)	end ?	Resident ?	084, 1 to FGH, 135, 1 to FGH,
COLLEMBOLA			
Entomobryidae	end ?	Resident ?	
more than 1 species			
COLEOPTERA			
Carabidae	?	Resident ?	
<i>Agonum cf. muelleri</i> (Herbst)	adv NSR	Resident ?	149, det. G.A. Samuelson (NSR = New State Record)
<i>Laemostenus complanatus</i> (Dejean)	adv	Aeolian	080b, 091, 182,
Cleridae			
<i>Necrobia rufipes</i> (DeGeer)	adv	Aeolian	117,
Coccinellidae			
<i>Coccinella septempunctata</i> L.	pur	Aeolian	112, 113, 117, 126, 131, 135, 136, 141, 147, 148, 149, 161a, 161b, 164, 171, 180, 182, 184, 224,
<i>Hippodamia convergens</i> Guerin-Meneville	pur	Aeolian	110, 112, 113, 117, 126, 128, 132, 136, 139, 141, 145, 147, 156, 159, 161b, 164, 171, 174, 178, 182, 203, 205, 218,
Dyticidae			
<i>Rhantus pacificus</i>	end	Resident	Not collected in 2008
Hydrophilidae			
?Genus ?species	pur ?	Aeolian	171, 173,
Staphylinidae			
<i>Creophilus maxillosus</i> (Linnaeus)	end ?	Resident	073, 110,
several species		Aeolian	094, 139, 197,
DERMAPTERA			
<i>Forficula forficularia</i>	adv	Resident	073, 076, 078, 083, 091, 094, 096, 101,

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DIPTERA					
Agromyzidae		adv	Aeolian	084, 156,	
Calliphoridae					076, 083, 107, 110, 113, 117, 135, 141, 147, 156, 159, 161a, 173, 176, 178, 182,
<i>Calliphora vomitoria</i> (Linnaeus)		adv	Aeolian ?		
Ceratopogonidae					
<i>Forcipomyia</i> sp.		end	Aeolian	099,	
Chironomidae		end ?	Aeolian	Not collected in 2008	
Drosophilidae					
<i>Drosophila</i> sp.		adv	Aeolian	131, 156, 161a, 161b, 171, 173, 176,	
Ephydriidae					
<i>Hydrellia tritici</i> Coquillett		adv	Aeolian	148, 164, 174, 184,	
Genus (?) species (?)		adv ?	Aeolian	072b, 112, 161b,	
Muscidae					
<i>Atherigona orientalis</i> Schiner		adv	Aeolian	Not collected in 2008	
<i>Haematobia irritans</i> (Linnaeus)		adv	Aeolian	101, 113, 174,	
<i>Stomoxys calcitrans</i> (Linnaeus)		adv	Aeolian	078, 112, 113, 135,	
				075, 076, 080, 080b, 091, 094, 096, 099, 101, 117, 124, 135,	
				140, 141, 144, 145, 147, 156, 161a, 161b, 164, 171,	
				173, 182, 184,	
Muscoidea (indet.)		adv ?	Aeolian		
Phoridae					
several species		adv ?	Aeolian	075, 080, 084, 084b, 094, 113, 117, 126, 128, 135, 148,	
				156, 161a, 161b, 164, 171, 174, 176, 182, 184,	
Sarcophagidae					
several species		adv	Aeolian	072, 073, 112, 126, 139, 156, 161a, 161b, 164, 174, 182,	
				184,	
Sciariidae					
? <i>Bradysia</i> sp.		end ?	Aeolian	113, 126, 141, 147, 148, 156, 161a, 164, 173, 176,	
<i>Sciara</i> sp.		adv ?	Aeolian	184,	
?Genus ?species		adv ?	Aeolian	080b, 144, 161b, 171,	
Sepsidae					
<i>Sepsis thoracica</i> (Robineau-Devoidy)		adv	Aeolian	072b, 080b, 084b, 092, 099, 076, 107, 112, 113, 117, 126,	
<i>Sepsis</i> sp. not <i>thoracica</i>		adv	Aeolian	131, 145, 147, 156, 164, 171, 173, 174, 176, 180, 191	
Sphaeroceridae					
<i>Copromyza equina</i> (Fallen)		adv	Aeolian	147, 164, 171,	
<i>Leptocera</i> (several species)		adv ?	Aeolian	220,	
				101, 113, 131, 148, 149, 161a, 161b, 171,	
				173, 220,	
Genus (?) species (?)		end ?	Resident ?	080b, 084, 113, 117, 126, 139, 141, 156,	
				161a, 176, 184, 218,	

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Syrphidae				099, 107, 112, 113, 117, 126, 131, 135, 140, 147, 148, 156, 161a, 161b, 164, 173, 176, 184, 173,
<i>Allograpta</i> sp.		pur	Aeolian	
<i>Eristalis tenax</i> (Linnaeus)		adv	Aeolian	
Tachinidae				
<i>Gonia longipalvilli</i> Tothill		adv	Aeolian	084b, 094, 131, 132, 139, 147, 148, 178,
<i>Phasiormia pallida</i> Townsend		adv	Aeolian	112,
?Genus ?species		adv	Aeolian	072b, 092, 145, 164, 173, 174, 176,
Tephritidae		adv ?	Resident ?	096,
DIPTERA : Family?		adv ?	Aeolian	117, 145, 156,
HETEROPTERA				
Lygaeidae				
<i>Geocoris pallens</i> Stal		adv	Resident	073, 147, 161a, 161b,
<i>Neocoryphus bicrucis</i> Say		adv	Aeolian	
<i>Nysius wehrlicola</i>				
Aschlock & Gagne		end	Resident	191, 194, 197, 203, 206, 208, 220, 224, 225, 173, 076, 078, 084b, 091, 094, 101, 112, 117, 126, 131, 135, 136, 149, 156, 161a, 161b, 164, 189, 073, 174, 176, 199,
<i>Nysius</i> sp. 1 = phytophagus		end	Aeolian	117, 141, 148, 171,
<i>Nysius</i> sp. 2 = phytophagus		end	Aeolian	
HOMOPTERA				
Aphidae				
Genus (?) species (?)		adv	Aeolian	080b, 084b, 099, 112, 117, 126, 128, 148, 161b, 164, 173,
Cicadellidae				
?Genus ?species		adv ?	Aeolian	096, 164, 184,
Psyllidae				
Genus (?) species (?)		adv ?	Aeolian	072, 099, 107, 112, 113, 135, 140, 141, 144, 147, 148, 156, 161a, 161b, 164, 171, 174, 176, 180, 182, 184, 218,
HYMENOPTERA				
Apidae				
<i>Apis mellifera</i>		adv	Aeolian	072, 072b, 113, 117, 161b,
Bethylidae				
<i>Sierola</i> sp.		end	Resident	072b, 080, 084b,
Braconidae				
<i>Apanteles</i> sp. spp.		pur ?	Aeolian ?	075, 084, 084b, 099, 107, 112, 117, 124, 126, 131, 135, 136, 139, 140, 141, 144, 147, 148, 156, 161a, 164, 171, 173, 174, 176, 184, 194, 218,
<i>Bracon</i> sp. 1		pur ?	Aeolian ?	076, 147,
?Genus ?species		adv	Aeolian	156,
Colletidae				
<i>Hyleaus</i> sp. spp.		end	Aeolian	072, 072b, 075,
Undetermined micro-hymenoptera		adv.	Aeolian	072, 080, 084, 096, 099, 144, 148, 156, 161b, 171, 173, 176, 184,

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Ichneumonidae					
<i>Diadegma blackburni</i> (Cresson)	adv	Aeolian	084b, 131, 147, 148, 156, 173,		
<i>Ichneumon cupitus</i> Cresson	adv	Aeolian	144, 161a, 164, 205,		
?Genus ?species	adv ?	Aeolian	078, 144, 156, 174,		
Megachilidae					
<i>Megachile timbertlakei</i> Cockerell	adv	Aeolian	107, 212,		
Sphecidae					
	adv	Aeolian	176,		
<i>Ecternitus</i> sp.	end	Aeolian	084b,		
?Genus ?species	adv ?	Aeolian	072b, 173,		
Vespidae					
<i>Polistes olivacitus</i>	adv	Aeolian	None		
LEPIDOPTERA					
Noctuidae					
<i>Agrotis</i> sp.	end	Resident	180, 212 larva,		
Oecophoridae					
<i>Agonopterix ulicetella</i>	pur	Aeolian	080b, 084, 113,		
Pterophoridae					
<i>Lantanophaga pusillidactyla</i> (Dyar)	pur	Aeolian	084b,		
LEPIDOPTERA: Family ?	adv ?	Aeolian	161a,		
PSOCOPTERA					
Psocidae					
?Genus ?species	adv ?	Resident ?	084,		
THYSANOPTERA					
Thripidae					
several species	end ?	Aeolian	072, 072b, 084, 112, 117, 126, 140, 144, 161a, 161b, 164,		