



RESULTS OF THE 2011 ALIEN SPECIES AND WĒKIU BUG
(NYSIUS WEKIUICOLA) SURVEYS ON THE SUMMIT
OF MAUNA KEA, HAWAII ISLAND

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Biological
Survey

Final Report

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RESULTS OF THE 2011 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 and Gagné), which is endemic to the Mauna Kea summit area of Hawai'i Island. A ten-day field trip was conducted in June 2011 to continue the monitoring of introduced arthropod species found at the Mauna Kea summit, and to continue monitoring wēkiu bug populations within known critical core habitats. The objective of the alien arthropod monitoring surveys was to provide information to managers on any potential threats to endemic Mauna Kea arthropod species such as the wēkiu bug. As was done in previous Monitoring surveys, traps for ants were set out to determine if they are found within wēkiu bug habitat. Ants are well established at the summit regions of Haleakalā National Park on Maui and spreading, and this elevational range is well within that of lowest elevation that wēkiu bugs have been found. Ants have caused the extinction and decline of native arthropods throughout Hawai'i. We placed traps in areas determined to be high-risk areas for ants to be found around the Mauna Kea summit region.

During the 2011 monitoring survey 3,084 wēkiu bugs were collected at selected cinder cones throughout the Mauna Kea summit region. We placed 100 alien arthropod traps at sites previously studied and at the proposed Thirty Meter Telescope (TMT), and the batch plant staging area. One new resident alien species was found during the 2011 alien arthropod species-monitoring season. An undetermined salticid spider was collected outside of Hale Pohaku. No ants were found from Hale Pohaku (2,755 m) to the highest point in the Hawaiian Islands of Pu'u Wēkiu (4,205 m). Aeolian arthropod drift capture density was much lower than in 2011 attributed mainly to catch interruption due to an unusual snowfall event requiring resetting many of the traps. Although by-catch numbers were down species diversity remained similar to the 2010-trapping season.

INTRODUCTION

The Hawaii Biological Survey of the Bishop Museum was contracted for the 2011 field season by the Office of Mauna Kea Management (OMKM) to continue to monitor and document alien arthropod species found at the Mauna Kea summit area. A baseline for alien arthropod species currently occurring at the Mauna Kea summit area has been established and species with the potential to negatively affect wēkiu bugs (*Nysius wekiuicola* Ashlock and Gagné) or other native arthropod species are being monitored. Additionally, to provide long-term capture data in areas of known critical wēkiu bug habitat, wēkiu bug population monitoring continued during the 2011 field season 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, 2009, 2010, Porter and Englund 2006).

The main objectives for the 2011 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 plus less favored habitats, 2) compare the 2011 alien arthropod species composition to the 2010 field season at the summit areas on Mauna Kea where people traffic is high, including observatory buildings, the Hale Pohaku visitor center, and roadways, 3) repeat a baseline survey following the 2009 field season methods for alien arthropod species including 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) continue to monitor wēkiu bug populations in selected known wēkiu bug habitats to provide comparisons to previous Bishop Museum surveys.

STUDY AREA

The overall study area for the 2011 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, 2009, 2010) and Porter and Englund (2006), and was similar to the 2007-2008 study area (Englund *et al.* 2009). 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 instead 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 2011 fieldwork was to documenting alien species found within the Mauna Kea summit area. Identifications were made of all arthropod species collected during the 2011 field trip with comparisons to previous



Alien sampling at Lake Waiau
Photograph by L. Englund

catches and referenced to authoritatively identified specimens in the Bishop Museum's entomology collections. Species were identified to the lowest possible taxonomic unit for all trapping methods except sticky traps. Sticky traps were scanned for species that may pose a threat to the wēkiu bugs. The specimen would then be removed from the sticky trap with a solvent and identified to the lowest possible taxonomic unit. All arthropod identifications made were dependent upon expertise available for each taxonomic group.

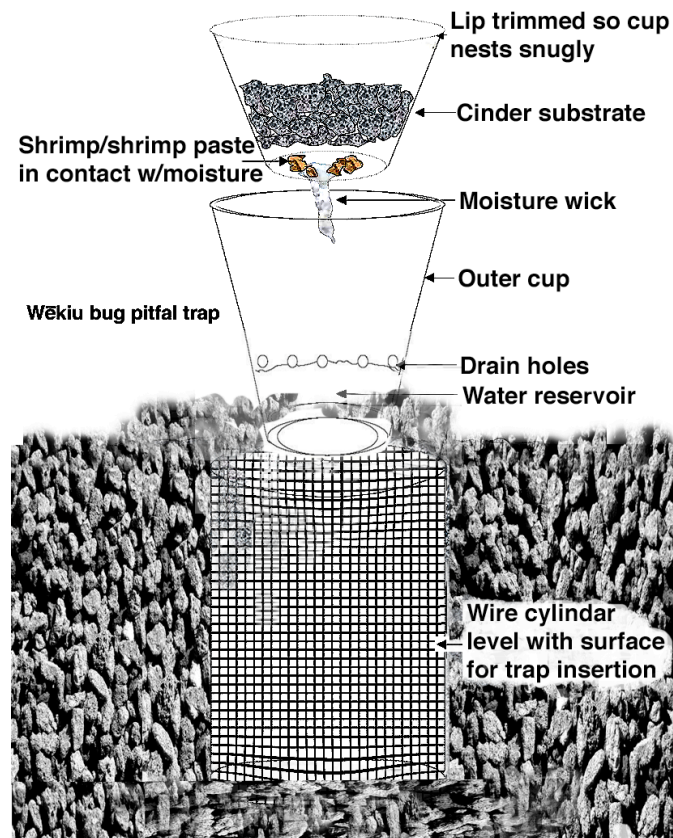
The main purpose of fieldwork of the 2011 study was to continue to monitor for alien species and identify species on Mauna Kea having the potential to negatively affect wēkiu bugs and other native arthropods. To accomplish this goal we sampled at previous trapping sites over a broad range of habitats 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 historically known to have high concentrations, and nearby disturbed habitats that are associated with past or present human activities. Trapping followed the 2009 field season protocols. Yellow pan traps and yellow sticky traps were used to collect flying insects that are attracted to the color of the traps and the shimmering of the dilute ethylene glycol used in the pan traps. The pan and sticky traps were secured so that they did not become dislodged or blown from the trap sites and become scattered over the summit area. Ethylene glycol was used because it prevents freezing during the nighttime temperatures and is a preservative keeping the arthropod specimen from rotting until they can be processed and identified. Glycol pitfall traps were constructed as in previous

year's wēkiu bug traps (Englund *et al.* 2002), they are baited with shrimp paste around their cup rims and around a cap-rock used to cover the traps to prevent rain or snow from filling the traps. The traps are filled with a mixture of water and glycol. The glycol pitfall traps were not placed in habitats likely to contain wēkiu bugs.

Ants have become a major concern in Hawaii and are ranked as one of the greatest threats to native arthropods including the wēkiu bug. Monitoring for the presence of ants is of the utmost importance. Ants were sampled for in high traffic areas where vehicles and people activities occur. Sampling areas included the Onizuka Visitor Center picnic and trashcan locations. The Hale Pohaku staff areas and the summit lunchroom building as well as several observatory structures were trapped for ants. Ant traps rely on baits as attractants. Peanut butter has proven to be excellent bait and it is a simple and easy way to sample for ants. Ant traps were constructed using wooden tongue depressors dipped into peanut butter and placed in areas previously sampled in 2009 and 2010. The ant traps were checked at 2-3 day intervals through out the 10-day fieldwork. Shrimp baited traps were also checked. It should be noted that the shrimp bait will also attract ants and served to provide additional monitoring points.

A total of 4 different trapping methods were employed during the 2011 trapping season at selected trapping locations: 1) peanut butter mainly for ants, 2) yellow sticky traps for flying insects but also effective when placed on the ground for crawling arthropods, 3) yellow pan traps used mainly for flying insects but when placed level with the cinders acts like a shallow pitfall trap capturing crawling arthropods, and 4) a single ethylene glycol pitfall trap, effective for catching crawling as well as flying arthropods especially flies. Traps were placed between 4 and 5 meters from one another and a GPS point was recorded for each trap at each trapping location. Traps ran for a minimum of 3 days. Fluid traps were checked for evaporation and filled as needed. Table 1 in Appendix B lists the collection site localities as well as each trap coordinate.



Wēkiu Bug Sampling

As in 2010, glycol pitfall traps were not used in areas known or suspected to contain wēkiu bugs. During the 2011 fieldwork, wēkiu bug sampling consisted of using baited shrimp pitfall traps (which generally do not harm the insects) in areas of previously

known wēkiu bug populations. Limited visual surveys for wēkiu bugs were also conducted. A detailed explanation of techniques used for shrimp pitfall traps in this study can be found in Englund *et al.* (2002). Individual wēkiu bug pitfall trap locations were recorded with GPS (WGS 84 datum), and locations where wēkiu bugs were visually observed. Trap locations, dates, habitat type, and habitat descriptions can be found in Appendix B, Table 2 for the 2011 sampling.

RESULTS AND DISCUSSION

The study period at the Mauna Kea summit for alien arthropod and wēkiu bug sampling ran from May 31 – June 9, 2011. Tables 2 and 3 (Appendix B) summarize trap locations by cinder cone, elevation, date set, trap type, and GPS coordinates. Overall the 2011 wēkiu bug sample effort consisted of 50 pitfall traps and 100 alien arthropod traps. An unexpected snowfall event caused many of the wēkiu bug traps to become filled with snow effectively causing the wēkiu bug traps to stop functioning for two days resulting in a lower by-catch volume this season. Although the numbers of aeolian arthropods were lower, species diversity was comparable to previous years trapping. Wēkiu bug numbers were similar to captures made in 2010. All live wēkiu bugs were counted and released. All dead wēkiu bugs were counted and retained. By-catch arthropods were retained for identification and are kept in the collections of the Bishop Museum. Non-identified material is retained and stored at the Bishop Museum for future analysis.

Wēkiu Bug Trap Placements in Study Area

A total of 50 shrimp pitfall traps, were set in various cinder cone areas at selected elevations during the 2011 fieldwork season (Figure 2, Table 2). Sampled areas from 2011 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, south of the VLBA, and Poi Bowl. Other areas sampled included the proposed Thirty Meter Telescope (TMT) site and the batch plant staging area that will be used if the TMT is built.

Wēkiu Bug Collections

A total of 3,084 wēkiu bugs were collected in early June 2011 during a total of 300 trap days, for an average catch of 10.30 wēkiu bugs/trap-day (Table 3). The 2011 sampling coincided with sampling done during the summer of 2011, when 3,047 bugs were captured during same effort of 300 trap days. Pu‘u Hau Kea has been intensively sampled nearly every year since 2001 because of its unaltered habitat and usually high wēkiu bug captures. Wēkiu bug collection data from the Pu‘u Hau Kea monitoring station in 2011 is summarized in Table 4.

Summary of Arthropod Species Collected in 2011

The following is a summary of arthropods collected in discrete sampling areas during the 2011 field season, including a brief description of sample location along with any arthropod by-catch found during wēkiu bug collections. Detailed GPS locations and additional 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, which is why many have question marks next to their habitat and their (end/adv/native/introduced) status. The following abbreviations in the 2011 species tables are based upon Nishida (2002):

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

ind = indigenous: native to the Hawaiian islands but can be found elsewhere

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

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

unk = unknown

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 are brief descriptions of the 2011 sample areas followed by a list of species for each area. Areas or sample sites with no insect collections are not included in the list below.

HP Parking Lot (lower) (Sites 001, 002, 003, 004)

Hale Pohaku parking lot area: Located near the Hale Pohaku living quarters and cafeteria, this area was located at an elevation of approximately 2,850 m. In 2011 an undetermined salticid spider was collected outside of Hale Pohaku. This undetermined spider may be a one-off occurrence but it should be monitored to determine if it is an established resident species. Two endemic species of note were either observed or collected. Still present were the native *Hyaleus* sp. bees, along with a native seed bug (Lygaeidae). The native *Thyrocopa* sp. moth was not seen during the 2011 trapping season. Alien ant species were not collected in this area (or anywhere at the Mauna Kea summit area at or above Hale Pohaku) in 2011.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Gnaphosidae	<i>Urozelotes rusticus</i> (L. Koch, 1872)	adv	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes cf. tenuis</i> (Blackwell, 1852)	adv	Resident
COLEOPTERA	Carabidae	<i>Laemostenus complanatus</i> (Dejean, 1828)	adv	Resident
COLEOPTERA	Coccinellidae	<i>Coccinella septempunctata</i> Linnaeus, 1758	pur	Aeolian
COLEOPTERA	Coccinellidae	?Genus ?species (larva)	pur	Aeolian
COLEOPTERA	Staphylinidae	?Genus ?species	unk	Resident
DERMAPTERA	Forficulidae	<i>Forficula auricularia</i> Linnaeus, 1758	adv	Resident
DIPTERA	Agromyzidae	?Genus ?species	adv	Aeolian
DIPTERA	Calliphoridae	<i>Chrysomya megacephala</i> (Fabricius, 1794)	adv	Aeolian
DIPTERA	Calliphoridae	?Genus ?species	adv	Aeolian
DIPTERA	Muscidae	?Genus ?species	adv	Aeolian
DIPTERA	Sciaridae	several species	adv	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Resident
HETEROPTERA	Lygaeidae	<i>Graptostethu smanillensis</i> (Stål, 1862)	adv	Aeolian
HETEROPTERA	Lygaeidae	<i>Nysius sp.</i>	end?	Resident
HETEROPTERA	Nabidae	<i>Nabis capsiformis</i> Germar, 1837	adv	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> several spp.	adv	Resident
HYMENOPTERA	Chalcidoidea	several species	adv	Resident

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HYMENOPTERA	Colletidae	<i>Hylaeus sp.</i>	end	Resident
HYMENOPTERA	Ichneumonidae	<i>Diadegma blackburni</i> (Cameron, 1883)	adv	Resident
HYMENOPTERA	Braconidae	<i>Apanteles sp.</i>	adv	Aeolian
THYSANOPTERA	Thripidae	<i>Frankliniella sp.</i>	adv	Aeolian

Onizuka Visitor Center (Sites 005, 006, 007, 008)

Sampling took place around the parking lot and around the trashcans at the visitor center, with negative results for ants. Of interest, the native *Hylaeus sp.* bees were still found at this site but the rare flightless native moth *Thyrocopa kikaelekea* recently described by Medeiros (2008) was not seen during the 2011 trapping season. Of particular concern, is the presence of the predatory/scavenger earwig *Forficula auricularia* which may have a negative impact on the native flightless moth.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Corinnidae	<i>Meriola arcifera</i> (Simon, 1886)	adv	Resident
ARANEAE	Gnaphosidae	<i>Urozelotes rusticus</i> (L. Koch, 1872)	adv	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes cf. tenuis</i> (Blackwell, 1852)	adv	Resident
ARANEAE	Salticidae	?Genus?species	adv	Resident
COLEOPTERA	Carabidae	<i>Laemostenus complanatus</i> (Dejean, 1828)	adv	Resident
COLEOPTERA	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville, 1844	pur	Aeolian
DERMAPTERA	Forficulidae	<i>Forficula auricularia</i> Linnaeus, 1758	adv	Resident
DIPTERA	Agromyzidae	<i>Liriomyza sp.</i>	adv	Aeolian
DIPTERA	Calliphoridae	<i>Chrysomya megacephala</i> (Fabricius, 1794)	adv	Aeolian
DIPTERA	Ephydriidae	<i>Hydrellia tritici</i> Coquillett, 1903	adv	Aeolian
DIPTERA	Mycetophilidae	<i>Leia sp.</i> [of Evenhuis, 1986]	unk	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Muscidae	?Genus?species	unk	Aeolian
DIPTERA	Phoridae	several species	unk	Aeolian
DIPTERA	Sarcophagidae	<i>Sarcophaga argyrostoma</i> (Robineau-Desvoidy, 1830)	adv	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
DIPTERA	Sciaridae	several species	unk	Aeolian
DIPTERA	Sphaeroceridae	<i>Leptocera sp.</i>	adv	Aeolian
DIPTERA	Tachinidae	?Genus ?species	unk	Aeolian
HETEROPTERA	Lygaeidae	<i>Nysius sp.</i>	end?	Resident
HOMOPTERA	Psyllidae	?Trioxa sp.	end	Aeolian
HYMENOPTERA	Apidae	<i>Apis mellifera</i> Linnaeus, 1758	pur	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> several spp.	adv	Aeolian
HYMENOPTERA	Colletidae	<i>Hylaeus sp.</i>	end	Resident
HYMENOPTERA	Ichneumonidae	<i>Diadegma blackburni</i> (Cameron, 1883)	adv	Aeolian
HYMENOPTERA	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson, 1877	adv	Aeolian
HYMENOPTERA	Ichneumonidae	<i>Ichneumon laetus</i> Brulle, 1846	pur	Aeolian
HYMENOPTERA	Scelionidae	?Genus ?species	pur?	Aeolian
HYMENOPTERA	Sphecidae	<i>Pison hospes</i> R. Smith, 1879	adv	Aeolian

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HYMEOPTERA	Pompilidae	<i>Anoplius toluca</i> (Cameron, 1893)	adv	Aeolian
THYSANOPTERA	Thripidae	<i>Frankliniella</i> sp.	adv	Aeolian

VLBA Parking Lot and Wēkiu trap by-catch (Sites VLBA24, VLBA100 - 104, VLBA105 - 109)

Only 6 alien species were trapped in the region around the VLBA parking lot (3,725 m elevation), and found in the by-catch of the wēkiu traps placed at one Pu‘u north and another south of the VLBA. All species captured were aeolian except for the resident linyphiid spiders now widespread at the summit region.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Lycosidae	<i>Lycosa hawaiiensis</i> Simon, 1899	end	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes</i> cf. <i>tenuis</i> (Blackwell, 1852)	adv	Resident
DIPTERA	Calliphoridae	<i>Lucilia sericata</i> (Meigen, 1826)	adv	Aeolian
DIPTERA	Calliphoridae	several species	adv	Aeolian
DIPTERA	Muscidae	<i>Atherigona orientalis</i> Schiner, 1868	adv	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian

Burns Cone Parking Lot (Site BURNS43)

This area was located at a parking lot at 3,667 m elevation and was near an unnamed cinder cone at the John Burns Highway sign. Sampling at this location consisted of peanut butter traps, glycol pitfall, sticky, and yellow pan traps. Ant traps were negative and no harmful alien species collected.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
DIPTERA	Ephydriidae	?Genus ?species	unk	Aeolian
DIPTERA	Calliphoridae	<i>Lucilia sericata</i> (Meigen, 1826)	adv	Aeolian
DIPTERA	Calliphoridae	several species	adv	Aeolian
DIPTERA	Muscidae	<i>Atherigona orientalis</i> Schiner, 1868	adv	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Phoridae	?Genus ?species	unk	Aeolian
DIPTERA	Scarcophagidae	several species	unk	Aeolian
DIPTERA	Sciaridae	several species	unk	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
HETEROPTERA	Lygaeidae	<i>Nysius</i> sp.	end?	Resident
HOMOPTERA	Psyllidae	?Genus ?species	end	Aeolian

Batch Plant Parking Lot (trailhead area to Lake Waiau) (Sites 048, 049, 050, 051)

The batch plant parking lot is a large, flat, graded area at approximately 4,063–4,105 m elevation, adjacent to the base of Pu‘u Hau Kea. This area is also used as a parking lot for visitor day hikes to Lake Waiau. The native aeolian psyllid (*Trioza* sp.) was present here again but in lower numbers compared to 2010. A potentially harmful introduced linyphiid spider was found in the batch plant parking lot area during the 2011 sampling. This species appears to be widespread throughout the summit region and also found at lower elevations around Hale Pohaku and the Onizuka visitor center. This spider has been collected in previous surveys of the Mauna Kea summit area.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Linyphiidae	<i>Lepthyphantes</i> cf. <i>tenuis</i> (Blackwell, 1852)	adv	Resident
DIPTERA	Calliphoridae	<i>Chrysomya megacephala</i> (Fabricius, 1794)	adv	Aeolian
DIPTERA	Calliphoridae	<i>Lucilia sericata</i> (Meigen, 1826)	adv	Aeolian
DIPTERA	Calliphoridae	several species	adv	Aeolian
DIPTERA	Tachinidae	several species	adv	Aeolian
DIPTERA	Muscidae	?Genus ?species	unk	Aeolian
DIPTERA	Phoridae	several species	unk	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sphaeroceridae	several species	adv	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
DIPTERA	Tachinidae	several species	adv	Aeolian
HOMOPTERA	Psyllidae	?Genus ?species	end	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> (several spp.)	adv	Aeolian

Pu‘u Hau Kea (Sites 009, 010, 011, 012, 013, 014, 015, 016, 018)

This cinder cone was part of our continued wēkiu bug monitoring during the 2011 field season. By-catch of alien arthropod species were found in wēkiu bug shrimp traps. No potentially harmful alien arthropod species were collected here. The native aquatic ephydrid *Brachydeutera hebes* in was again found in wēkiu traps; these individuals are probably breeding at nearby Lake Waiau and attracted to the rotting shrimp paste used as bait in the wēkiu bug traps.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
COLEOPTERA	Coccinellidae	<i>Coccinella septempunctata</i> Linnaeus, 1758	pur	Aeolian
DIPTERA	Ephydriidae	<i>Brachydeutera hebes</i> Cresson, 1926	end	Aeolian
DIPTERA	Ephydriidae	<i>Hydrellia tritici</i> Coquillett, 1903	adv	Aeolian
DIPTERA	Phoridae	?Genus ?species	unk	Aeolian
DIPTERA	Sciaridae	several species	unk	Aeolian
DIPTERA	Sphaeroceridae	several species	unk	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> sp.	adv	Aeolian
HYMENOPTERA	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson, 1877	adv	Aeolian
HYMENOPTERA	Ichneumonidae	?Genus ?species	unk	Aeolian

Lake Waiau (Site Waiau7)

Although part of the Natural Area Reserve and not in the Science Reserve, Lake Waiau continued to be monitored in 2011 because the moisture provided by the lake in an otherwise desert environment is a major attractant to arthropods and potentially harmful alien species. Should harmful arthropods becoming established in the slightly more mild and moist microclimate around the lake's shores, they could potentially expand their range to the rest of the summit area, especially ants. The area we monitored included the Lake Waiau shoreline, grassy areas, muddy areas near shore, the intermittent stream outflow of the Lake, and the nearshore waters. The alien predatory carabid beetle species (*Agonum muelleri*) was not collected at Lake Waiau shoreline during the 2011 trapping season. In 2010 we collected 20 specimens of this carabid beetle suggesting they may be an established resident at the lake. It is likely this beetle is established at lower elevations in similar riparian habitats but searches were beyond the scope of the current project. This species is of potential concern as its dietary habits overlap with that of the wēkiu bug.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Corinnidae	<i>Meriola arcifera</i> (Simon, 1886)	adv	Resident
DERMAPTERA	Forficulidae	<i>Forficula auricularia</i> Linnaeus, 1758	adv	Resident
DIPTERA	Ephydriidae	?Genus ?species	unk	Aeolian
DIPTERA	Phoridae	?Genus ?species	unk	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> sp.	adv	Aeolian
HYMENOPTERA	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson, 1877	adv	Aeolian
LITHOBIOMORPHA	Henicopidae	<i>Lamyctes</i> sp. prob. <i>africana</i>	adv	Resident

Pu'u Wēkiu (Sites 029-038, 042)

In 2011 we set traps for alien arthropod species around the weather station area that was operating in the bottom of Pu'u Wēkiu crater. All arthropod by-catch in the wēkiu shrimp pitfall traps were analyzed and recorded. Except for two alien linyphiid spiders that are now residents at this site, all other arthropods collected here were aeolian species and thus not considered a threat to the wēkiu bug.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Linyphiidae	nr. <i>Agenata</i> sp.	adv	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes</i> cf. <i>tenuis</i> (Blackwell, 1852)	adv	Resident
DIPTERA	Calliphoridae	<i>Lucilia sericata</i> (Meigen, 1826)	adv	Aeolian
DIPTERA	Calliphoridae	several species	unk	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Phoridae	?Genus ?species	adv	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sciaridae	several species	unk	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1883	adv	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> several spp.	adv	Aeolian
HYMENOPTERA	Ichneumonidae	?Genus ?species	unk	Aeolian

Pu‘u Poliahu (Sites 019–023)

Five wēkiu bug pitfall traps were placed here a moderate amount of alien arthropod species was collected as by-catch during the 2011 field season compared to 2010. All species listed below were recovered from wēkiu shrimp pitfall traps and no alien species of concern were found in this known wēkiu bug habitat.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
DIPTERA	Calliphoridae	several species	unk	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sciaridae	?Genus ?species	unk	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl,1883	adv	Aeolian
DIPTERA	Sphaeroceridae	?Genus ?species	unk	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
HOMOPTERA	Psyllidae	?Genus ?species	unk	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> sp.	adv	Aeolian

Poi Bowl (Sites 121-125)

Poi Bowl is the locally named bowl-shaped ski slope area behind the Subaru and Keck telescopes, and is a known area of high wēkiu bug concentration. This area was sampled with five wēkiu bug pitfall traps. Below are the alien arthropods that were found as by-catch inside the wēkiu bug traps. Two alien linyphiid spider species of concern were found at Poi Bowl.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Linyphiidae	nr. <i>Agenata</i> sp.	adv	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes cf. tenuis</i> (Blackwell, 1852)	adv	Resident
COLEOPTERA	Staphylinidae	?Genus ?species	unk	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Phoridae	several species	unk	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl,1883	adv	Aeolian
DIPTERA	Sphaeroceridae	several species	unk	Aeolian
DIPTERA	Tachinidae	several species	adv	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> sp.	adv	Aeolian
HYMENOPTERA	Ichneumonidae	<i>Diadegma blackburni</i> (Cameron, 1883)	adv	Aeolian

Pu‘u Hau Oki and around Keck Observatory (Sites 025–028, 112)

The uppermost slopes of this cinder cone contain the Keck and Subaru Observatories. Trapping here included using alien arthropod insect traps placed near the Keck Observatory as well as wēkiu bug traps placed at selected areas of the cinder cone. A list of aeolian species recovered from all traps is found below. Two alien linyphiid spider species of concern were found here in 2011.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Linyphiidae	nr. <i>Agenata</i> sp.	adv	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes</i> cf. <i>tenuis</i> (Blackwell, 1852)	adv	Resident
COLEOPTERA	Coccinellidae	<i>Coccinella septempunctata</i> Linnaeus, 1758	pur	Aeolian
COLEOPTERA	Coccinellidae	<i>Harmonia conformis</i> (Boisduval, 1835)	pur	Aeolian
COLEOPTERA	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville, 1844	pur	Aeolian
COLEOPTERA	Staphylinidae	?Genus ?species	unk	Aeolian
DIPTERA	Phoridae	?Genus ?species	unk	Aeolian
DIPTERA	Sciaridae	?Genus ?species	unk	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
HETEROPTERA	Lygaeidae	<i>Geocoris pallens</i> Stål, 1854	adv	Aeolian
HOMOPTERA	Psyllidae	? <i>Trioza</i> sp.	end	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> sp.	adv	Aeolian

Summit Lunchroom (Site 110)

The area sampled here included areas inside and around the summit lunchroom building at 4223 m elevation. Insect traps were placed around the building, inside the building on trashcans, and in a long underground hallway area. Even though this area has food and high human traffic, no alien arthropod species of concerns were found here. No resident arthropod species were found around the lunchroom building in 2011, and all ant traps were negative as they were at other summit areas.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
COLEOPTERA	Staphylinidae	?Genus ?species	unk	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> several spp.	adv	Aeolian

Gemini Telescope (Site 111)

The Gemini telescope observatory building area was sampled with a variety of insect traps within a 0–5 m distance of the observatory buildings. Two alien linyphiid spider species of concern were found here in 2011. The remainder of the arthropod species collected here in 2011 was entirely aeolian and not considered residents or species that could become established in this area.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Linyphiidae	nr. <i>Agenata</i> sp.	adv	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes</i> cf. <i>tenuis</i> (Blackwell, 1852)	adv	Resident
DIPTERA	Phoridae	?Genus ?species	unk	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sciariidae	several species	unk	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
DIPTERA	Tachinidae	?Genus ?species	unk	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> several spp.	adv	Aeolian

Proposed Thirty Meter Telescope area (Sites 39, 40, 41)

This area is in the flats region within the proposed Thirty Meter Telescope (TMT) site. Wēkiu bugs have never been collected in or around the TMT site because it lies in a heavily glaciated region (Englund *et al.* 2007). In 2011 a comprehensive arthropod survey was again conducted here, including glycol pitfall and other various insect traps. Only one resident species was collected here, a tiny line-weaving spider in the family Linyphiidae. Baited ant traps were negative at the proposed TMT site, as they were elsewhere around the summit. The remainder of the arthropod species collected here in 2011 was entirely aeolian and not likely to become established in this area.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Corinnidae	<i>Meriola arcifera</i> (Simon, 1886)	adv	Resident
ARANEAE	Linyphiidae	nr. <i>Agenata</i> sp.	adv	Resident
COLEOPTERA	Staphylinidae	?Genus ?species	unk	Aeolian
DIPTERA	Calliphoridae	<i>Chrysomya megacephala</i> (Fabricius, 1794)	adv	Aeolian
DIPTERA	Muscidae	several species	unk	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
HOMOPTERA	Psyllidae	? <i>Trioza</i> sp.	end	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> several spp.	adv	Aeolian
HYMENOPTERA	Chalcidoidea	several species	unk	Aeolian

Pu‘u Pohaku (Sites 115–120)

This sample area was located in the Mauna Kea Natural Area Reserve and contains a small but consistent outlying wēkiu bug population. Two sets of alien arthropod traps were used in 2011 at this cinder cone, with one set at the base of the cinder cone, and the other set of traps near the summit around the intermittent Henderson Lake. No wēkiu bugs were captured at Pu‘u Pohaku. The by-catch from wēkiu bug traps set at Pu‘u Pohaku is included in the species list below.

order	family	genus-species-author	end/ind/adv/pur/unk	Resident/Aeolian
ARANEAE	Gnaphosidae	<i>Urozelotes rusticus</i> (L. Koch, 1872)	adv	Resident
ARANEAE	Lycosidae	<i>Lycosa hawaiiensis</i> Simon, 1899	end	Resident
ARANEAE	Linyphiidae	nr. <i>Agenata</i> sp.	adv	Resident
ARANEAE	Linyphiidae	<i>Lepthyphantes</i> cf. <i>tenuis</i> (Blackwell, 1852)	adv	Resident
COLEOPTERA	Coccinellidae	<i>Coccinella septempunctata</i> Linnaeus, 1758	pur	Aeolian
COLEOPTERA	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville, 1844	pur	Aeolian
DIPTERA	Phoridae	several species	unk	Aeolian
DIPTERA	Sarcophagidae	several species	adv	Aeolian
DIPTERA	Sciaridae	<i>Bradysia</i> sp.	unk	Aeolian
DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
DIPTERA	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy, 1830)	adv	Aeolian
DIPTERA	Sphaeroceridae	several species	unk	Aeolian
DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
HETEROPTERA	Miridae	<i>Coridromius variegates</i> (Montrouzier, 1861)	adv	Aeolian, on 'aweoweo at lower elevations
HOMOPTERA	Psyllidae	?Genus ?species	end	Aeolian
HYMENOPTERA	Braconidae	<i>Apanteles</i> sp.	adv	Aeolian
HYMENOPTERA	Chalcidoidea	several species	unk	Aeolian
HYMENOPTERA	Ichneumonidae	<i>Diadegma blackburni</i> (Cameron, 1883)	adv	Aeolian
PSOCOPTERA	Ectopsocidae	<i>Ectopsocus</i> sp.	adv	Aeolian
THYSANOPTERA	Phlaeothripidae	?Genus ?species	adv	Aeolian

Introduced Species of Concern and Potential Threats to Wēkiu Bugs

Alien ant species continue to be 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). Ants are also implicated in the decline of the rare flightless *Thyrocopa apatela* moth found around the summit area of Haleakalā crater, and a closely related flightless species (*Thyrocopa kikaeleka*) was recently described from the Mauna Kea summit region in 2008 (Medeiros 2008). The potential for ant invasion to the Mauna Kea summit region is high, as ants are abundant along the Saddle Road area around the Pu'u Huluhulu turnoff (Evenhuis *et al.* 1996). The European earwig was very common in 2011 and this was no different in 2011. It is predatory and a scavenger, and thus also has the potential to interact negatively with wēkiu bugs. These earwigs have never been found above the Hale Pohaku area and apparently are unable to handle the harsher summit conditions. However changes in climate could see this predator increase its elevational range

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 wider ranging native wolf spiders (generally the bugs are found in the upper portion of non-glaciated cinder cones), it is expected that wēkiu bugs would be even more vulnerable to ant invasions than the spiders. One new species of alien spider was found during the 2011 fieldwork that could potentially cause impacts to wēkiu bugs or other sensitive native biota. A small alien centipede was collected from the Lake Waiau area. This is the only site during this monitoring season that it was collected at but specimens of this species were collected in earlier surveys conducted by Francis G. Howarth in the early 1980's from higher elevations at the summit region. Although a predator, this centipede is mostly a scavenger, not widespread at the summit region and at this time not believed to be a serious risk to the wēkiu bug. The alien carabid beetle (*Agonum muelleri*) appeared to be increasing in numbers at the Lake Waiau area in 2010. The first specimen of *A. muelleri* was collected by Steven L. Montgomery in 2006 in a Berlese funnel from material collected near a snow bank at the UH 2.2 meter telescope at the Mauna Kea summit (Liebherr *et al.* 2009), but all other specimens since that time have been collected around the Lake Waiau shoreline. During the 2010 trapping season we collected 20 specimens of this beetle and at the present time it has not been collected at any other site during this and past Bishop Museum monitoring seasons. It seems to be restricted to the Lake area and is probably a riparian species not likely to survive the dry desert-like habitats that contain wēkiu bugs. Risk to native arthropods that are residents of the Lake Waiau area are at particular risk though. This predatory carabid beetle was not collected or observed during the 2011 trapping season. An unusual snow event may have caused this beetle to curtail its movements at the time the trapping was conducted. Further monitoring for this beetle should be continued.

Regular monitoring and a rapid response to any ant introduction in the summit areas, or along roadways going to the summit should continue to ensure the 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 at their lowest range. Earwigs have never been found above the Hale Pohaku area and apparently are unable to handle the harsher summit conditions.

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APPENDIX A: FIGURES

Figure 1. Overall study area for wēkiu bug sampling conducted during the 2011 field season.

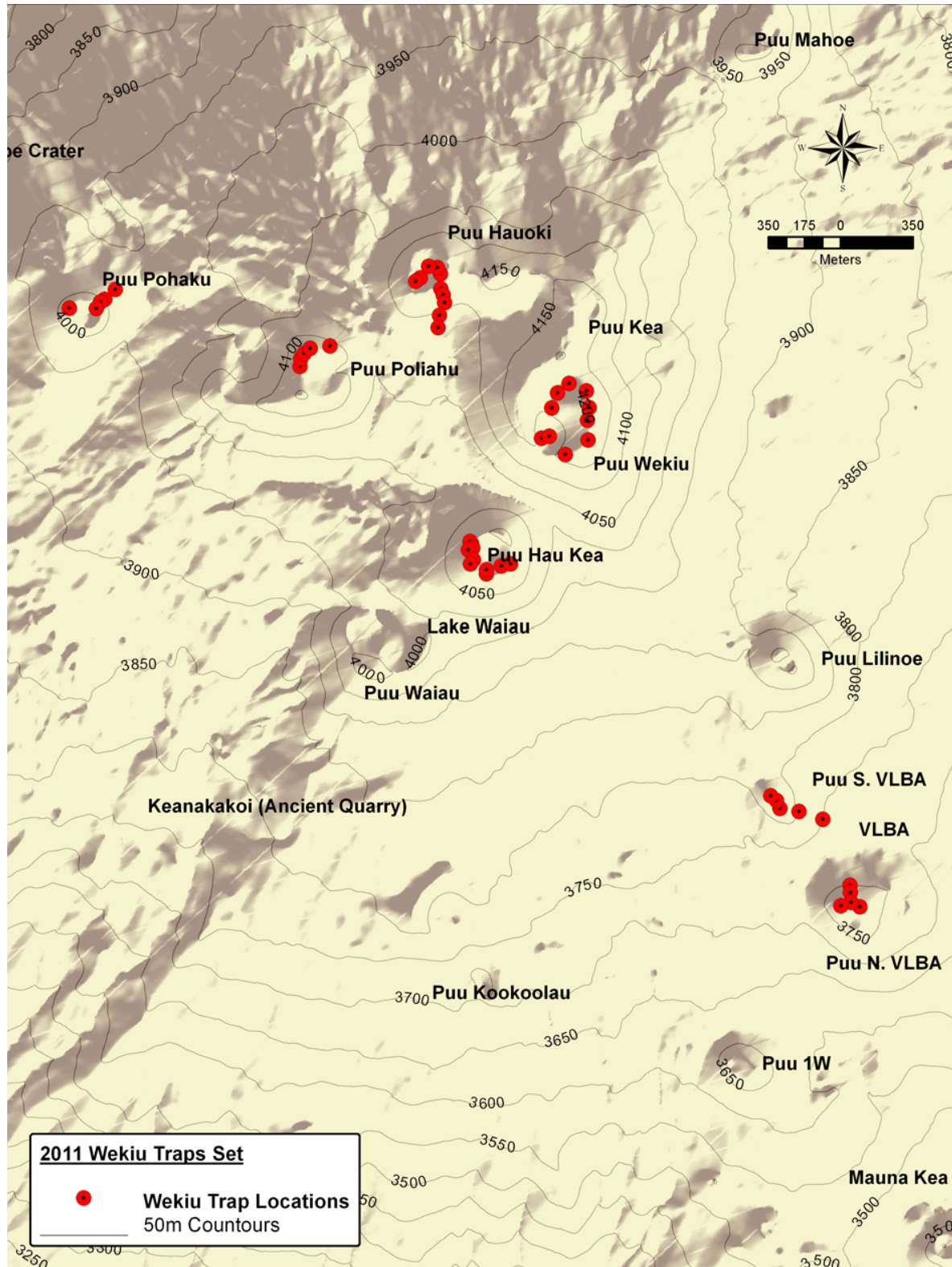


Figure 2. Wēkiu bug concentrations during the 2011 field season.

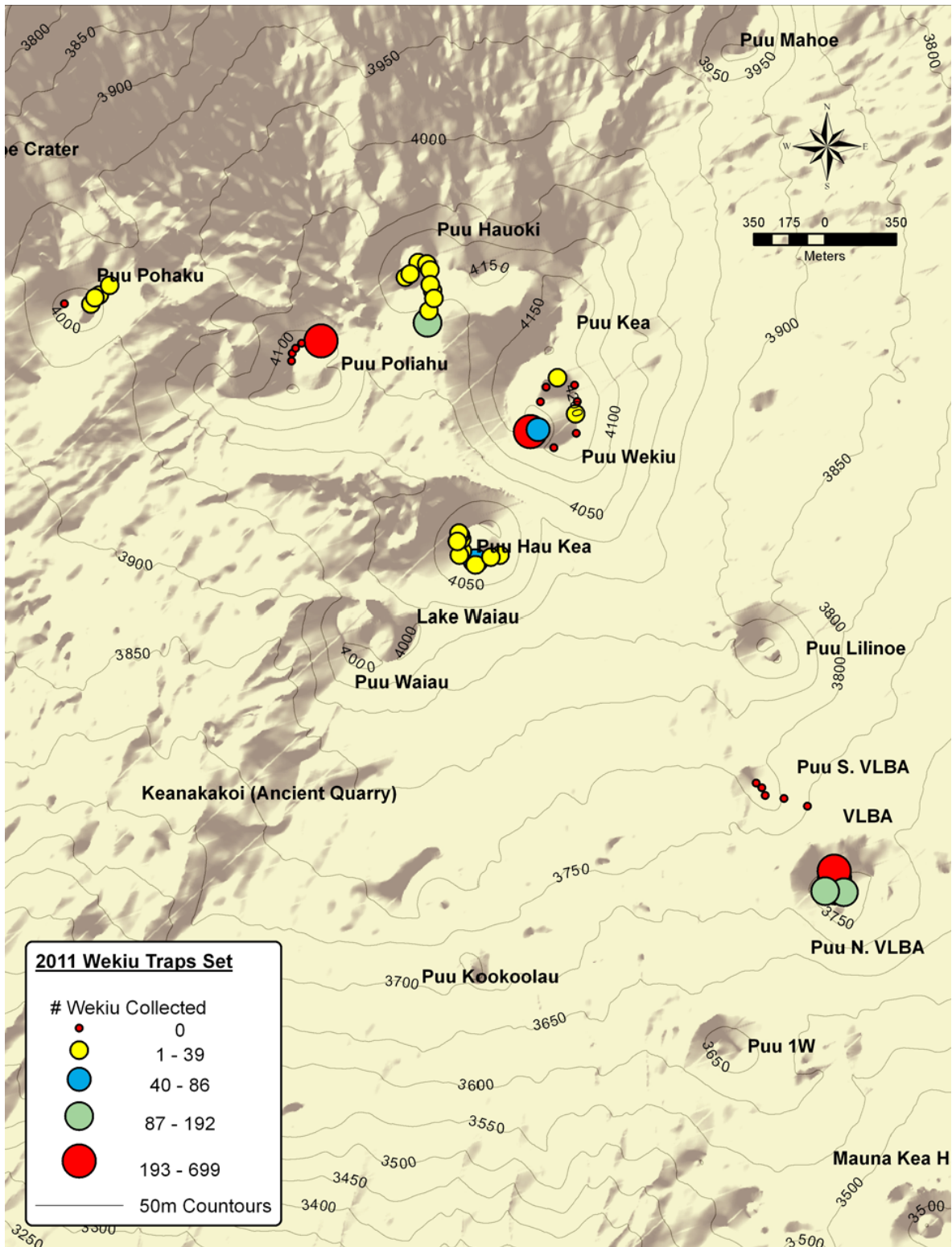


Figure 3. Overall study area for peanut butter trap sampling conducted during the 2011 field season.

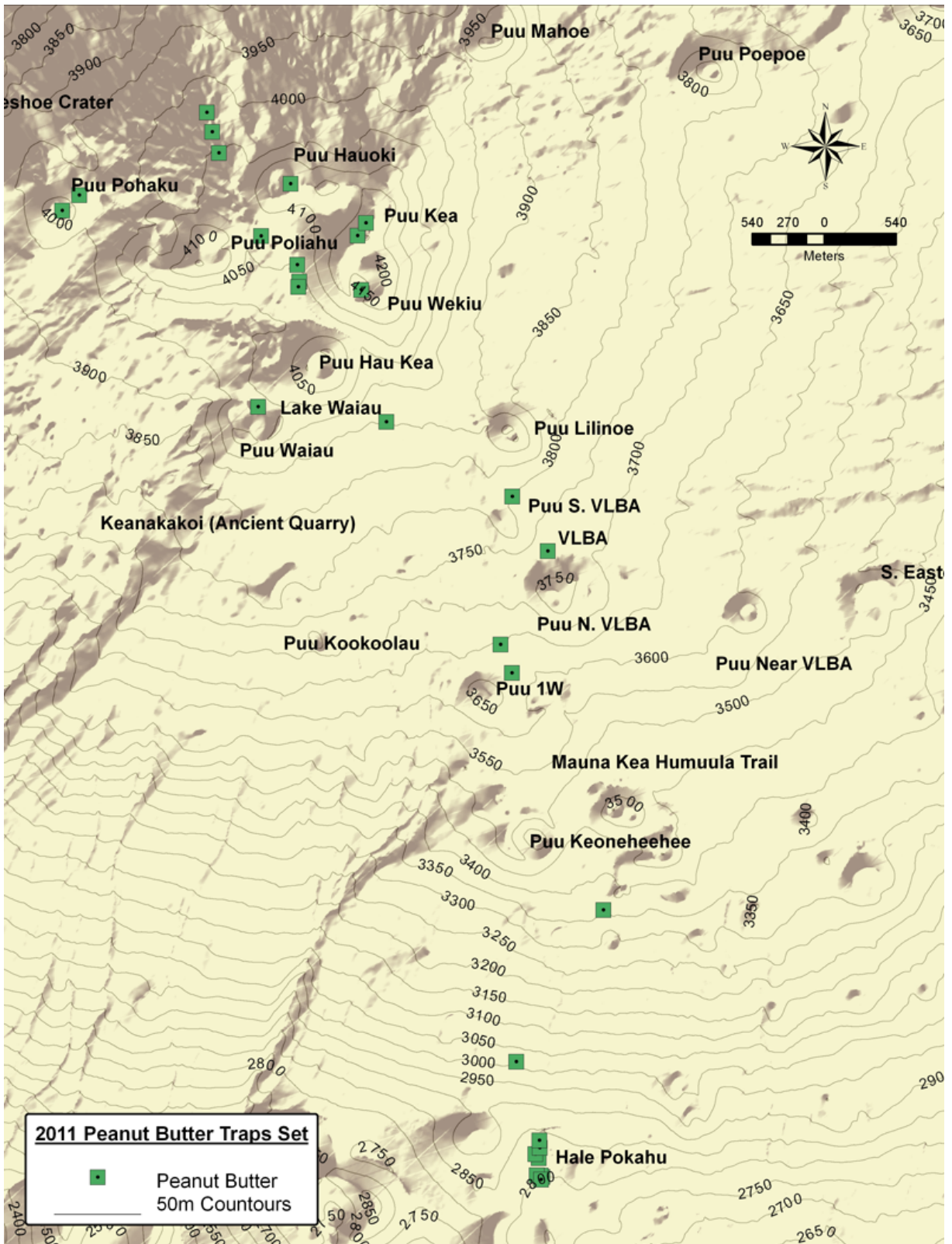


Figure 4. Overall study area for sticky trap sampling conducted during the 2011 field season.

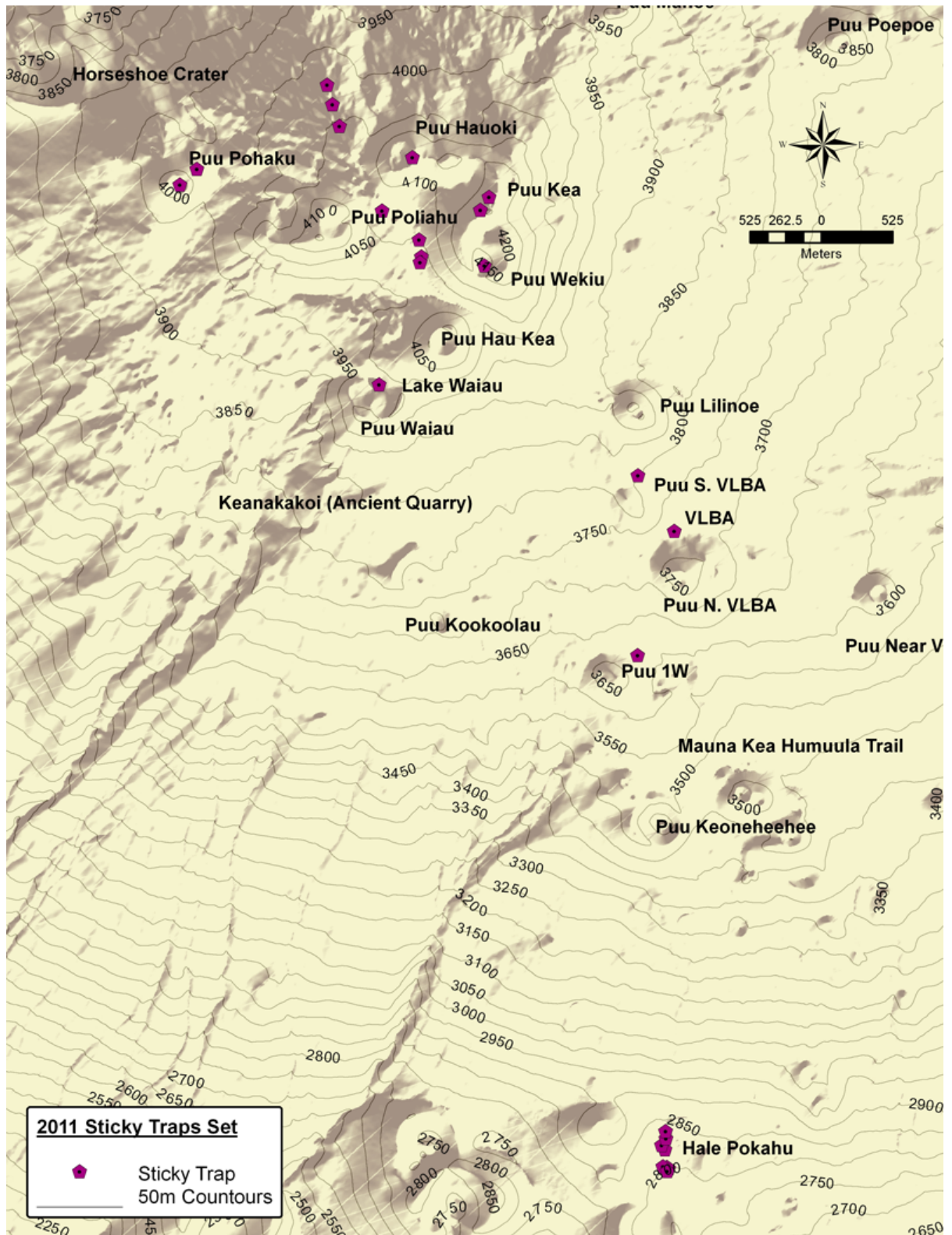


Figure 5. Overall study area for pitfall trap sampling conducted during the 2011 field season.

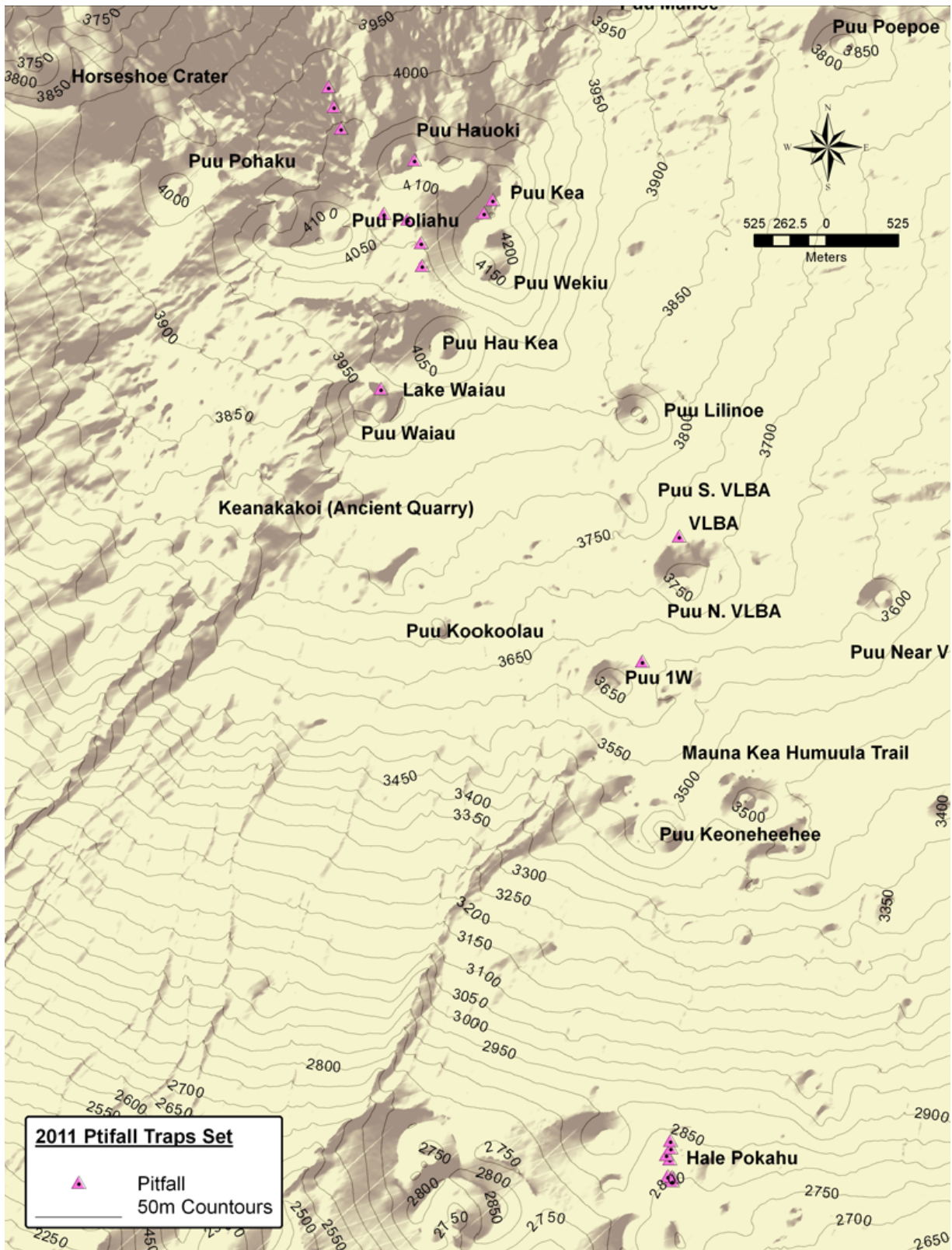
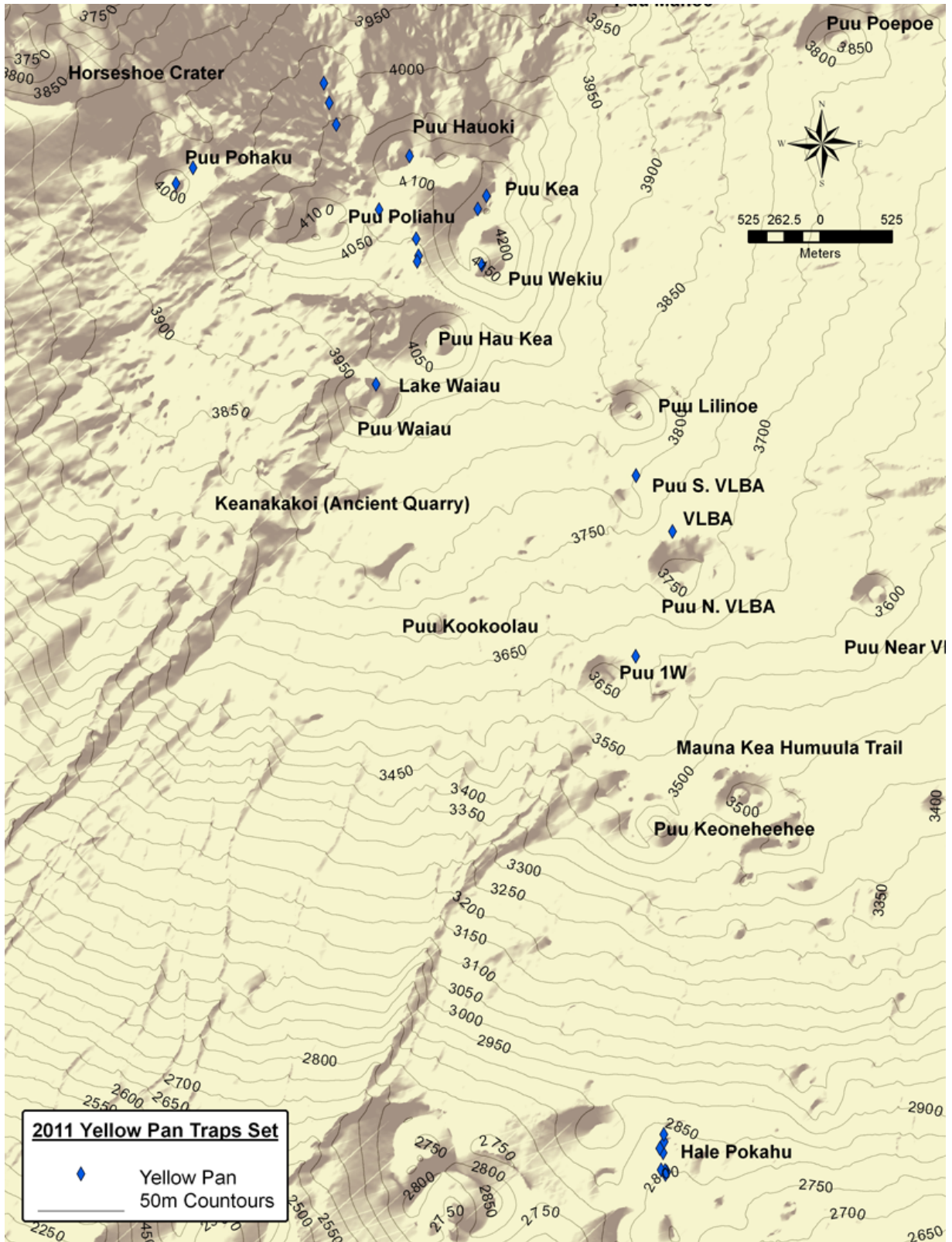


Figure 6. Overall study area for yellow pan trap sampling conducted during the 2011 field season.



APPENDIX B: TABLES

Table 1. Alien arthropod sampling locations for the 2011 field season.

Site Number	Locality	Date	Elevation in meters	GPS WGS 84	Habitat/Area	Trap type
001	Hale Pohaku	31 May -9 2011	2851	19.76059 N 155.45604 W	Parking (Lower)	Pitfall
001	Hale Pohaku	31 May -9 2011	2851	19.76059 N 155.45604 W	Parking (Lower)	Peanut butter
001	Hale Pohaku	31 May -9 2011	2851	19.76059 N 155.45604 W	Parking (Lower)	Yellow pan
001	Hale Pohaku	31 May -9 2011	2851	19.76059 N 155.45604 W	Parking (Lower)	Sticky trap
002	Hale Pohaku	31 May -9 2011	2853	19.76086 N 155.45627 W	Parking- Side opposite Kitchen	Peanut Butter
002	Hale Pohaku	31 May -9 2011	2853	19.76086 N 155.45627 W	Parking- Side opposite Kitchen	Sticky Trap
002	Hale Pohaku	31 May -9 2011	2853	19.76086 N 155.45627 W	Parking- Side opposite Kitchen	Pitfall
002	Hale Pohaku	31 May -9 2011	2853	19.76086 N 155.45627 W	Parking- Side opposite Kitchen	Yellow Pan
003	Hale Pohaku	31 May -9 2011	2865	19.76131 N 155.45598 W	Parking lot- Next to Kitchen	Peanut Butter
003	Hale Pohaku	31 May -9 2011	2865	19.76131 N 155.45598 W	Parking lot- Next to Kitchen	Sticky Trap
003	Hale Pohaku	31 May -9 2011	2865	19.76131 N 155.45598 W	Parking lot- Next to Kitchen	Pitfall
003	Hale Pohaku	31 May -9 2011	2865	19.76131 N 155.45598 W	Parking lot- Next to Kitchen	Yellow Pan
004	Hale Pohaku	31 May -9 2011	2868	19.76180 N 155.45601 W	Near the staircase to the Machine shop	Peanut Butter
004	Hale Pohaku	31 May -9 2011	2868	19.76180 N 155.45601 W	Near the staircase to the Machine shop	Sticky Trap
004	Hale Pohaku	31 May -9 2011	2868	19.76180 N 155.45601 W	Near the staircase to the Machine shop	Pitfall
004	Hale Pohaku	31 May -9 June 2011	2868	19.76180 N 155.45601 W	Near the staircase to the Machine shop	Yellow Pan
005	Onizuka Visitor Center	31 May -9 June 2011	2832	19.75933 N. 155.45576W	Picnic tables/trash cans	Peanut Butter
005	Onizuka Visitor Center	31 May -9 June 2011	2832	19.75933 N. 155.45576W	Picnic tables/trash cans	Sticky Trap

Table 1. Alien arthropod sampling locations for the 2011 field season.

Site Number	Locality	Date	Elevation in meters	GPS WGS 84	Habitat/Area	Trap type
005	Onizuka Visitor Center	31 May - 9 June 2011	2832	19.75933 N, 155.45576 W	Picnic tables/trash cans	Pitfall
005	Onizuka Visitor Center	31 May - 9 June 2011	2832	19.75933 N, 155.45576 W	Picnic tables/trash cans	Yellow Pan
006	Onizuka Visitor Center	31 May - 9 June 2011	2833	19.75941 N, 155.45587 W	uphill side of parking lot near light pole	Peanut Butter
006	Onizuka Visitor Center	31 May - 9 June 2011	2833	19.75941 N, 155.45587 W	uphill side of parking lot near light pole	Sticky Trap
006	Onizuka Visitor Center	31 May - 9 June 2011	2833	19.75941 N, 155.45587 W	uphill side of parking lot near light pole	Pitfall
006	Onizuka Visitor Center	31 May - 9 June 2011	2833	19.75941 N, 155.45587 W	uphill side of parking lot near light pole	Yellow Pan
007	Onizuka Visitor Center-	31 May - 9 June 2011	2833	19.75944 N, 155.45616 W	Above parking lot by mamane trees	Peanut Butter
007	Onizuka Visitor Center	31 May - 9 June 2011	2833	19.75944 N, 155.45616 W	Above parking lot by mamane trees	Sticky Trap
007	Onizuka Visitor Center	31 May - 9 June 2011	2833	19.75944 N, 155.45616 W	Above parking lot by mamane trees	Pitfall
007	Onizuka Visitor Center-	31 May - 9 June 2011	2833	19.75944 N, 155.45616 W	Above parking lot by mamane trees	Yellow Pan
008	Onizuka Visitor Center-	31 May - 9 June 2011	2831	19.75915 N, 155.45584 W	Mamane Grove immediately by bathroom area	Peanut Butter
008	Onizuka Visitor Center	31 May - 9 June 2011	2831	19.75915 N, 155.45584 W	Mamane Grove immediately by bathroom area	Sticky Trap
008	Onizuka Visitor Center	31 May - 9 June 2011	2831	19.75915 N, 155.45584 W	Mamane Grove immediately by bathroom area	Pitfall
008	Onizuka Visitor Center-	31 May - 9 June 2011	2831	19.75915 N, 155.45584 W	Mamane Grove immediately by bathroom area	Yellow Pan
Waiau 7	Lake Waiau	1-7 June 2011	3990	19.81122 N, 155.47691 W	Near the Shoreline	Peanut Butter
Waiau 7	Lake Waiau	1-7 June 2011	3990	19.81122 N, 155.47691 W	Near the Shoreline	Sticky Trap
Waiau 7	Lake Waiau	1-7 June 2011	3990	19.81122 N, 155.47691 W	Near the Shoreline	Pitfall
Waiau 7	Lake Waiau	1-7 June 2011	3990	19.81122 N, 155.47691 W	Near the Shoreline	Yellow Pan

Table 1. Alien arthropod sampling locations for the 2011 field season.

Site Number	Locality	Date	Elevation in meters	GPS WGS 84	Habitat/Area	Trap type
PB 001	10,000 ft. Marker	1-7 June 2011	3032	19.76710 N 155.45775 W	Roadside in cobble/cinder/sand	Peanut Butter
PB 002	11,000 ft. Marker	1-7 June 2011	3390	19.77748 N 155.45166 W	Roadside in cobble/cinder/sand	Peanut Butter
PB 003	12,000 ft. Marker	1-7 June 2011	3658	19.79535 N 155.45930 W	cobble/cinder behind boulder	Peanut Butter
PB 004	13,000 ft. Marker	1-7 June 2011	3932	19.81034 N 155.46770 W	Roadside in cobble/cinder on slope	Peanut Butter
048	Batch Plant Area- by Maxwell	1-7 June 2011	4106	19.82279 N 155.47687 W	cobble/gravel/sand	Sticky
048	Batch Plant Area- by Maxwell	1-7 June 2011	4106	19.82279 N 155.47687 W	cobble/gravel/sand	Peanut Butter
048	Batch Plant Area- by Maxwell	1-7 June 2011	4106	19.82279 N 155.47687 W	cobble/gravel/sand	Pitfall
048	Batch Plant Area- by Maxwell	1-7 June 2011	4106	19.82279 N 155.47687 W	cobble/gravel/sand	Yellow Pan
049	Batch Plant Area- Cal Tech side	1-7 June 2011	4100	19.82243 N 155.47520 W	Large cobble on flat area with cinder and gravel	Pitfall
049	Batch Plant Area- Cal Tech side	1-7 June 2011	4056	19.81976 N 155.47408 W	Large cobble on flat area with cinder and gravel	Sticky
049	Batch Plant Area- Cal Tech side	1-7 June 2011	4056	19.81976 N 155.47408 W	Large cobble on flat area with cinder and gravel	Peanut Butter
049	Batch Plant Area- Cal Tech side	1-7 June 2011	4056	19.81976 N 155.47408 W	Large cobble on flat area with cinder and gravel	Yellow Pan
050	Batch Plant Area- midway below Cal Tech	1-7 June 2011	4082	19.82089 N 155.47426 W	Among boulders adjacent to main rd. on cindery substrate	Yellow Pan
050	Batch Plant Area- midway below Cal Tech	1-7 June 2011	4082	19.82089 N 155.47426 W	Among boulders adjacent to main rd. on cindery substrate	Sticky
050	Batch Plant Area- midway below Cal Tech	1-7 June 2011	4082	19.82089 N 155.47426 W	Among boulders adjacent to main rd. on cindery substrate	Peanut Butter
050	Batch Plant Area- midway below Cal Tech	1-7 June 2011	4082	19.82089 N 155.47426 W	Among boulders adjacent to main rd. on cindery substrate	Pitfall
051	Batch Plant Area- adjacent to portable toilets	1-7 June 2011	4064	19.81938 N 155.47415 W	On ground - sand area adjacent to guardrail on downhill side of toilets	Yellow Pan

Table 1. Alien arthropod sampling locations for the 2011 field season.

Site Number	Locality	Date	Elevation in meters	GPS WGS 84	Habitat	Trap type
051	Batch Plant Area- adjacent to portable toilets	1-7 June 2011	4064	19.81938 N 155.47415 W	On ground - sand area adjacent to guardrail on downhill side of toilets	Sticky
051	Batch Plant Area- adjacent to portable toilets	1-7 June 2011	4064	19.81938 N 155.47415 W	On ground - sand area adjacent to guardrail on downhill side of toilets	Pitfall
051	Batch Plant Area- adjacent to portable toilets	1-7 June 2011	4064	19.81938 N 155.47415 W	On ground - sand area adjacent to guardrail on downhill side of toilets	Peanut Butter
042	Pu'u Wēkiu: by weather station	2-8 June 2011	4148	19.81924° N 155.46964°W	crater floor by weather station, cobbly, some cinder	Yellow Pan
042	Pu'u Wēkiu: by weather station	2-8 June 2011	4148	19.81924° N 155.46964°W	crater floor by weather station, cobbly, some cinder	Sticky
042	Pu'u Wēkiu: by weather station	2-8 June 2011	4148	19.81924° N 155.46964°W	crater floor by weather station, cobbly, some cinder	Peanut Butter
024	VLBA Facility Parking Lot	2-8 June 2011	3753	19.80174°N 155.45601	parking lot	Pitfall
024	VLBA Facility Parking Lot	2-8 June 2011	3753	19.80174°N 155.45601	parking lot	Peanut Butter
024	VLBA Facility Parking Lot	2-8 June 2011	3753	19.80174°N 155.45601	parking lot	Sticky
024	VLBA Facility Parking Lot	2-8 June 2011	3753	19.80174°N 155.45601	parking lot	Yellow Pan
200	Pu'u Lilinoe	2-8 June 2011	3824	19.80541°N 155.45863°W	sandy glaciated valley floor	Yellow Pan
200	Pu'u Lilinoe	2-8 June 2011	3824	19.80541°N 155.45863°W	sandy glaciated valley floor	Sticky
200	Pu'u Lilinoe	2-8 June 2011	3824	19.80541°N 155.45863°W	sandy glaciated valley floor	Peanut Butter
110	Summit Lunchroom	2-8 June 2011	4223	19.82292°N 155.46996°W	food service building area	Peanut Butter
110	Summit Lunchroom	2-8 June 2011	4223	19.82292°N 155.46996°W	food service building area	Pitfall

Table 1. Alien arthropod sampling locations for the 2011 field season.

Site Number	Locality	Date	Elevation in meters	GPS (N) WGS 84	GPS (W) WGS 84	Habitat	Trap type
110	Summit Lunchroom	2-8 June 2011	4223	19.82292°N	155.46996°W	food service building area	Sticky
110	Summit Lunchroom	2-8 June 2011	4223	19.82292°N	155.46996°W	food service building area	Yellow Pan
111	Gemini Scope	2-8 June 2011	4213	19.82379°N	155.46938°W	cobble	Peanut Butter
111	Gemini Scope	2-8 June 2011	4213	19.82379°N	155.46938°W	cobble	Pitfall
111	Gemini Scope	2-8 June 2011	4213	19.82379°N	155.46938°W	cobble	Sticky
200	Pu'u Liliioe	2-8 June 2011	3824	19.80541°N	155.45863°W	sandy glaciated valley floor	Yellow Pan
111	Gemini Scope	2-8 June 2011	4213	19.82379°N	155.46938°W	cobble	Yellow Pan
112	Keck	2-8 June 2011	4174	19.82637°N	155.47481°W	by back staircase of Keck	Peanut Butter
112	Keck	2-8 June 2011	4174	19.82637°N	155.47481°W	by back staircase of Keck	Pitfall
112	Keck	2-8 June 2011	4174	19.82637°N	155.47481°W	by back staircase of Keck	Sticky
112	Keck	2-8 June 2011	4174	19.82637°N	155.47481°W	by back staircase of Keck	Yellow Pan
039	Thirty Meter Scope	3-9 June 2011	4044	19.83112°N	155.48088°W	glaciated rock area	Peanut Butter
039	Thirty Meter Scope	3-9 June 2011	4044	19.83112°N	155.48088°W	glaciated rock area	Pitfall
039	Thirty Meter Scope	3-9 June 2011	4044	19.83112°N	155.48088°W	glaciated rock area	Sticky
039	Thirty Meter Scope	3-9 June 2011	4044	19.83112°N	155.48088°W	glaciated rock area	Yellow Pan
040	Thirty Meter Scope	3-9 June 2011	4058	19.82981°N	155.48047°W	glaciated valley floor area	Pitfall
040	Thirty Meter Scope	3-9 June 2011	4058	19.82981°N	155.48047°W	glaciated valley floor area	Yellow Pan

Table 1. Alien arthropod sampling locations for the 2011 field season.

Site Number	Locality	Date	Elevation in meters	GPS WGS 84	Habitat	Trap type
040	Thirty Meter Scope	3-9 June 2011	4058	19.82981°N 155.48047°W	glaciated valley floor area	Sticky
040	Thirty Meter Scope	3-9 June 2011	4058	19.82981°N 155.48047°W	glaciated valley floor area	Peanut Butter
041	Thirty Meter Scope	3-9 June 2011	4068	19.82838°N 155.47997°W	glaciated valley floor area	Pitfall
041	Thirty Meter Scope	3-9 June 2011	4068	19.82838°N 155.47997°W	glaciated valley floor area	Yellow Pan
041	Thirty Meter Scope	3-9 June 2011	4068	19.82838°N 155.47997°W	glaciated valley floor area	Sticky
041	Thirty Meter Scope	3-9 June 2011	4068	19.82838°N 155.47997°W	glaciated valley floor area	Peanut Butter
043	Burns Cone	3-9 June 2011	3667	19.79345°N 155.45845°W	glaciated valley floor area	Pitfall
043	Burns Cone	3-9 June 2011	3667	19.79345°N 155.45845°W	glaciated valley floor area	Yellow Pan
043	Burns Cone	3-9 June 2011	3667	19.79345°N 155.45845°W	glaciated valley floor area	Sticky
043	Burns Cone	3-9 June 2011	3667	19.79345°N 155.45845°W	glaciated valley floor area	Peanut Butter
114	Pu'u Pohaku	3-9 June 2011	4001	19.82538°N 155.48994°W	outer slope, cobbly	Peanut Butter
114	Pu'u Pohaku	3-9 June 2011	4001	19.82538°N 155.48994°W	outer slope, cobbly	Yellow Pan
114	Pu'u Pohaku	3-9 June 2011	4001	19.82538°N 155.48994°W	outer slope, cobbly	Sticky
119	Pu'u Pohaku	3-9 June 2011	4033	19.82432°N 155.49113°W	flat cobble section where "lake" occurs	Peanut Butter
119	Pu'u Pohaku	3-9 June 2011	4033	19.82432°N 155.49113°W	flat cobble section where "lake" occurs	Yellow Pan
119	Pu'u Pohaku	3-9 June 2011	4033	19.82432°N 155.49113°W	flat cobble section where "lake" occurs	Sticky

Table 2. Wēkiu bug trap sites and capture data from the 2011 field season.

Sample Number	Cinder Cone	Date	Elevation in Meters	GPS WGS 84	Wēkiu #'s	Trap Type
009	Puu Hau Kea-Poliahu side	1-7 June 2011	4124	19.81455 N 155.47333 W	4	Wēkiu bug
010	Puu Hau Kea-Just below the rim	1-7 June 2011	4120	19.81463 N 155.47339 W	3	Wēkiu bug
011	Puu Hau Kea-Inside Crater	1-7 June 2011	4116	19.81436 N 155.47325 W	30	Wēkiu bug
012	Puu Hau Kea-Cinder- crater rim-Keck side	1-7 June 2011	4125	19.81426 N 155.47346 W	2	Wēkiu bug
013	Puu Hau Kea	1-7 June 2011	4118	19.81383 N 155.47322 W	36	Wēkiu bug
014	Puu Hau Kea	1-7 June 2011	4128	19.81365 N 155.47336 W	4	Wēkiu bug
015	Puu Hau Kea	1-7 June 2011	4124	19.81323 N 155.47261 W	23	Wēkiu bug
016	Puu Hau Kea	1-7 June 2011	4115	19.81342 N 155.47261 W	86	Wēkiu bug
017	Puu Hau Kea	1-7 June 2011	4116	19.81358 N 155.47192 W	9	Wēkiu bug
018	Puu Hau Kea	1-7 June 2011	4126	19.81368 N 155.47151 W	10	Wēkiu bug
019	Pu'u Poliahu	1-7 June 2011	4150	19.82215 N 155.48135 W	0	Wēkiu bug
020	Pu'u Poliahu	1-7 June 2011	4152	19.82250 N 155.48131 W	0	Wēkiu bug
021	Pu'u Poliahu	1-7 June 2011	4162	19.82272 N 155.48116 W	0	Wēkiu bug
022	Pu'u Poliahu	1-7 June 2011	4160	19.82294 N 155.48088 W	0	Wēkiu bug
023	Pu'u Poliahu	1-7 June 2011	4139	19.82306 N 155.47998 W	371	Wēkiu bug
025	Pu'u Hau Oki	2-8 June 2011	4151	19.82608°N 155.47586°W	1	Wēkiu bug
026	Pu'u Hau Oki	2-8 June 2011	4164	19.82593°N 155.47607°W	19	Wēkiu bug
027	Pu'u Hau Oki	2-8 June 2011	4171	19.82628°N 155.47493°W	23	Wēkiu bug
028	Pu'u Hau Oki	2-8 June 2011	4162	19.82654°N 155.47507°W	27	Wēkiu bug
008	Pu'u Hau Oki	2-8 June 2011	4144	19.82659°N 155.47549°W	39	Wēkiu bug
029	Pu'u Wēkiu: inner slope	2-8 June 2011	4196	19.82158°N 155.46893°W	1	Wēkiu bug
030	Pu'u Wēkiu: outer slope	2-8 June 2011	4214	19.82126°N 155.46812°W	0	Wēkiu bug
031	Pu'u Wēkiu	2-8 June 2011	4225	19.82054°N 155.46799°W	0	Wēkiu bug
032	Pu'u Wēkiu: inside slope on ahu side	2-8 June 2011	4215	19.81999°N 155.46806°W	1	Wēkiu bug
033	Pu'u Wēkiu: outer slope	2-8 June 2011	4207	19.81913°N 155.46802°W	0	Wēkiu bug
034	Pu'u Wēkiu: outer slope	2-8 June 2011	4186	19.81848°N 155.46906°W	0	Wēkiu bug
035	Pu'u Wēkiu: inner crater 2/3 down	2-8 June 2011	4159	19.81917°N 155.47017°W	395	Wēkiu bug
036	Pu'u Wēkiu, crater floor	2-8 June 2011	4148	19.81927°N 155.46980°W	55	Wēkiu bug
037	Pu'u Wēkiu	2-8 June 2011	4178	19.82050°N 155.46971°W	0	Wēkiu bug
038	Pu'u Wēkiu	2-8 June 2011	4183	19.82116°N 155.46945°W	0	Wēkiu bug
115	Pu'u Pohaku, base nr. weather station	3-9 June 2011	4004	19.82538°N 155.48991°W	4	Wēkiu bug
116	Pu'u Pohaku, outer slope near drainage	3-9 June 2011	4026	19.82495°N 155.49039°W	9	Wēkiu bug
117	Pu'u Pohaku, slope adjacent to drainage	3-9 June 2011	4035	19.82483°N 155.49059°W	2	Wēkiu bug

Table 2. cont. Wēkiu bug trap sites and capture data from the 2011 field season.

Sample Number	Cinder Cone	Date	Elevation in Meters	GPS WGS 84	Wēkiu #'s	Trap Type
118	Pu'u Pohaku, flat top of Pu'u	3-9 June 2011	4036	19.82454°N 155.49078°W	3	Wēkiu bug
120	Pu'u Pohaku, summit slope	3-9 June 2011	4044	19.82454°N 155.49202°W	0	Wēkiu bug
121	Poi Bowl - right behind Keck	3-9 June 2011	4168	19.82563°N 155.47490°W	4	Wēkiu bug
122	Poi Bowl	3-9 June 2011	4153	19.82536°N 155.47479°W	9	Wēkiu bug
123	Poi Bowl - mid-way down	3-9 June 2011	4144	19.82502°N 155.47472°W	3	Wēkiu bug
124	Poi Bowl	3-9 June 2011	4123	19.82447°N 155.47495°W	14	Wēkiu bug
125	Poi Bowl	3-9 June 2011	4105	19.82393°N 155.47501°W	150	Wēkiu bug
VLBAN 100	Pu'u N. VLBA	3-9 June 2011	3776	19.80279°N 155.45695°W	0	Wēkiu bug
VLBAN 101	Pu'u N. VLBA	3-9 June 2011	3819	19.80312°N 155.45805°W	0	Wēkiu bug
VLBAN 102	Pu'u N. VLBA	3-9 June 2011	3860	19.80325°N 155.45892°W	0	Wēkiu bug
VLBAN 103	Pu'u N. VLBA	3-9 June 2011	3858	19.80358°N 155.45909°W	0	Wēkiu bug
VLBAN 104	Pu'u N. VLBA	3-9 June 2011	3864	19.80379°N 155.45935°W	0	Wēkiu bug
VLBAS 105	Pu'u S. VLBA	3-9 June 2011	3770.00	19.79994°N 155.45564°W	340	Wēkiu bug
VLBAS 106	Pu'u S. VLBA	3-9 June 2011	3786.00	19.79963°N 155.45563°W	699	Wēkiu bug
VLBAS 107	Pu'u S. VLBA	3-9 June 2011	3811.00	19.79901°N 155.45518°W	192	Wēkiu bug
VLBAS 108	Pu'u S. VLBA	3-9 June 2011	3809.00	19.79919°N 155.45558°W	389	Wēkiu bug
VLBAS 109	Pu'u S. VLBA	3-9 June 2011	3806.00	19.79904°N 155.45605°W	135	Wēkiu bug

Table 3. Summary of 2011 sample effort and wēkiu bug captures from surveyed Mauna Kea cinder cones using shrimp pitfall traps in June 2011.

Cinder Cone	Highest Elevation	Total Traps	Wēkiu bugs in traps	Wēkiu bugs visual observation only	Trap Dates	Total Trap Days ¹
Pu‘u Hau Kea	4,128 m	10	207	0	1–7 Jun	60
Pu‘u Hau Oki	4,171.49 m	5	109	0	2–8 Jun	30
Pu‘u Wēkiu	4,225.44 m	10	452	0	2–8 Jun	60
Pu‘u N. VLBA	3,864 m	5	0	0	2–8 Jun	30
Pu‘u S. VLBA	3,811 m	5	1755	0	2–8 Jun	30
Pu‘u Pohaku	4,046 m	5	10	0	3–9 Jun	30
Pu‘u Poliahu	4,169.66 m	5	371	0	1–7 Jun	30
Poi Bowl	4,168 m	5	180	0	3–9 Jun	30
Totals		50	3084	0		300

¹Trap days = total nights x total traps per cinder cone.

Table 4. 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, 2008, 2009, 2010 and 2011 when only shrimp traps were used.

Year and Month when Trapping Occurred	Total Wēkiu bugs	Trap Days	Catch Corrected for Effort (Bugs/Trap Day)
2001 (June) (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
2009 (July)	1	60	0.02
2010 (June)	261	60	4.35
2011 (May/June)	207	60	3.4
			Avg = 2.71

¹Data from Polhemus (2001) was from glycol traps only and results may not be directly comparable to our shrimp traps.

APPENDIX C: ALIEN AND NATIVE ARTHROPOD TABLES 2011

Table 5. Overall species list of native and alien arthropods found during the 2011 field season, specific sites where each taxa were found are listed in main text.

Taxa	Order	Family	Genus-Species-Author	Biogeographic Status: (end/ind adv/pur/unk)	Resident/Aeolian
1	ARANEAE	Corinnidae	<i>Meriola arcifera</i> (Simon, 1886)	adv	Resident
2	ARANEAE	Gnaphosidae	<i>Urozelotes rusticus</i> (L. Koch, 1872)	adv	Resident
3	ARANEAE	Lycosidae	<i>Lycosa hawaiiensis</i> Simon, 1899	end	Resident
4	ARANEAE	Linyphiidae	<i>Lepthyphantes</i> cf. <i>tenuis</i> (Blackwell, 1852)	adv	Resident
5	ARANEAE	Linyphiidae	nr. <i>Agenata</i> sp.	adv	Resident
6	COLEOPTERA	Carabidae	<i>Laemostenus complanatus</i> (Dejean, 1828)	adv	Resident
7	COLEOPTERA	Coccinellidae	<i>Coccinella septempunctata</i> Linnaeus, 1758	pur	Aeolian
8	COLEOPTERA	Coccinellidae	<i>Harmonia conformis</i> (Boisduval, 1835)	pur	Aeolian
9	COLEOPTERA	Coccinellidae	<i>Hippodamia convergens</i> Guerin-Meneville, 1844	pur	Aeolian
	COLEOPTERA	Staphylinidae	?Genus ?species	unk	Aeolian
10	DERMAPTERA	Forficulidae	<i>Forficula auricularia</i> Linnaeus, 1758	adv	Resident
11	DIPTERA	Agromyzidae	?Genus ?species	adv	Aeolian
12	DIPTERA	Calliphoridae	<i>Chrysomya megacephala</i> (Fabricius, 1794)	adv	Aeolian
13	DIPTERA	Calliphoridae	<i>Lucilia sericata</i> (Meigen, 1826)	adv	Aeolian
14	DIPTERA	Calliphoridae	?Genus ?species	adv	Aeolian
15	DIPTERA	Ephydriidae	<i>Brachydeutera hebes</i> Cresson, 1926	end	Aeolian
16	DIPTERA	Ephydriidae	?Genus ?species	unk	Aeolian
17	DIPTERA	Mycetophilidae	<i>Leia</i> sp. [of Evenhuis, 1986]	end	Aeolian
18	DIPTERA	Muscidae	<i>Atherigona orientalis</i> Schiner, 1868	adv	Aeolian
19	DIPTERA	Muscidae	several species	unk	Aeolian
20	DIPTERA	Phoridae	several species	unk	Aeolian
21	DIPTERA	Sphaeroceridae	<i>Leptocera</i> sp.	adv	Aeolian
22	DIPTERA	Sarcophagidae	several species	unk	Aeolian
23	DIPTERA	Sciaridae	several species	unk	Aeolian
24	DIPTERA	Sepsidae	<i>Sepsis biflexuosa biflexuosa</i> Strobl, 1893	adv	Aeolian
25	DIPTERA	Sepsidae	<i>Sepsis thoracica</i> (Robineau-Desvoidy, 1830)	adv	Aeolian
26	DIPTERA	Sphaeroceridae	several species	unk	Aeolian
27	DIPTERA	Syrphidae	<i>Toxomerus marginatus</i> (Say, 1823)	adv	Aeolian
28	DIPTERA	Tachinidae	several species	adv	Aeolian
29	DIPTERA	Nematocera	indet. Fam.	unk	Aeolian
30	HETEROPTERA	Lygaeidae	<i>Geocoris pallens</i> Stål, 1854	adv	Aeolian
31	HETEROPTERA	Lygaeidae	<i>Nysius</i> sp.	end?	Resident
32	HETEROPTERA	Miridae	<i>Coridromius variegates</i> (Montrouzier, 1861)	adv	Resident on 'aweoweo
33	HOMOPTERA	Psyllidae	? <i>Trioxa</i> sp.	end	Aeolian
34	HYMENOPTERA	Braconidae	<i>Apanteles</i> sp.	adv	Aeolian
35	HYMENOPTERA	Chalcidoidea	several species	unk	Aeolian
36	HYMENOPTERA	Colletidae	<i>Hylaeus</i> sp.	end	Resident
37	HYMENOPTERA	Ichneumonidae	<i>Diadegma blackburni</i> (Cameron, 1883)	adv	Aeolian

Table 5. Cont. Overall species list of native and alien arthropods found during the 2011 field season, specific sites where each taxa were found are listed in main text.

Taxa	Order	Family	Genus-Species-Author	Biogeographic Status: (end/ind adv/pur/unk)	Resident/Aeolian
38	HYMENOPTERA	Ichneumonidae	<i>Ichneumon cupitus</i> Cresson, 1877	adv	Aeolian
39	HYMENOPTERA	Ichneumonidae	<i>Ichneumon laetus</i> Brulle, 1846	pur	Aeolian
40	HYMENOPTERA	Ichneumonidae	?Genus ?species	unk	Aeolian
41	HYMEOPTERA	Pompillidae	<i>Anoplius toluca</i> (Cameron, 1893)	adv	Aeolian
42	HYMENOPTERA	Sphecidae	<i>Pison hospes</i> R. Smith, 1879	adv	Aeolian
43	LITHOBIOMORPHA	Henicopidae	<i>Lamyctes</i> cf. <i>emarginatus</i> (Newport 1884)	adv	Resident
44	PSOCOPTERA	Ectopsocidae	<i>Ectopsocus</i> sp.	adv	Aeolian