Programmatic Arthropod Monitoring at the Haleakalā High Altitude Observatories and Haleakalā National Park Maui, Hawai‘i

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II. EXECUTIVE SUMMARY

The National Science Foundation (NSF) has authorized the development of the Daniel K. Inouye Solar Telescope (DKIST), previously known as the Advanced Technology Solar Telescope (ATST)) within the 18-acre University of Hawai`i Institute for Astronomy High Altitude Observatories (HO) site. The DKIST represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The DKIST project will be the largest and most capable solar telescope in the world. It will be an indispensable tool for exploring and understanding physical processes on the Sun that ultimately affect Earth. The DKIST Project will be contained within a 0.74 acre site footprint in the HO site. An Environmental Impact Statement was completed for the DKIST project (NSF 2009), and the NSF issued a Record of Decision in December of 2009.

The Haleakalā National Park (HALE) Road Corridor is being used for transportation during construction and use of the DKIST. The HO and HALE road corridor contain biological ecosystems that are both unique and fragile. The landscape at HO is considered to be an alpine dry shrub land vegetation type and resources along the Park road corridor are grouped into alpine and subalpine shrub land habitat zones, depending upon the elevation. These habitats contain several native and non-native species of plants, animals, and arthropods. While the overall impacts on Hawaiian native arthropod resources within the Park road corridor during the construction phase would be considered minor, NSF has committed to several mitigation measures to reduce the impacts to these biological resources, including programmatic monitoring for active preservation of invertebrates before, during and after construction of the DKIST Project.

After preliminary sampling near the HALE Entrance Station and at the DKIST site in 2009, Programmatic Arthropod Monitoring and Assessment at the Haleakalā High Altitude Observatories and Haleakalā National Park was initiated with two sampling sessions in 2010. Monitoring is being conducted twice a year during the construction phase of the DKIST which began in December 2012. Semi-annual monitoring has occurred in 2011, 2012, 2013, 2014, 2015, 2016, and 2017.

This report presents the results of the Winter 2017 sampling. The goal is to

monitor the arthropod fauna at the DKIST site and along the HALE Road Corridor, identify Hawaiian native arthropod species or habitats, if any, that may be impacted by construction of the DKIST, and detect and identify alien invasive arthropod species that could have adverse impacts on the flora and fauna on Haleakalā. Programmatic Arthropod Monitoring studies are being coordinated and conducted with the approval of HALE.

This monitoring project provides a means of gathering reliable information that can be used to protect the native Arthropod species during development of observatory facilities and supports astronomy programs at the Haleakala High Altitude Observatory Site by promoting the good stewardship of the natural resources located there.

In addition to semi-annual monitoring required by the FEIS, pursuant to the approved HCP and published BO, an inspection for non-indigenous arthropod species is required to be conducted on an ongoing annual basis during the approximate 5-year construction phase and 50 year lifespan of the DKIST for programmatic monitoring. Facilities and grounds within 100 feet of the DKIST observatory buildings are to be thoroughly inspected for introduced species that may have eluded the cargo inspection processes or transported to the site by construction personnel. This year that inspection will occur in September.

Programmatic arthropod monitoring was conducted April 8 - 16, 2017. The pitfall traps (10 per site) were installed Saturday April 8, 2017 and picked up Sunday April 16, 2017. Light traps were set the nights of April 8 – 14, 2017 with the exception of April 13 due to rainy weather (a total of 6 trap nights at each site). Baiting for ants was done at all three sites on April 9, 2017 (50 cards at HO/DKIST, 14 cards at HALE-ES). Weather was good at the beginning and end of the monitoring period, but there were several days of cold, wet weather from Tuesday April 10 to Friday April 13, 2017, and this made it difficult to sample vegetation or flying insects, so sampling focused on leaf and detritus litter sampling during those days.

III. INTRODUCTION

Programmatic Monitoring

The Haleakalā volcano on the island of Maui is one of the highest mountains in Hawai`i, reaching an elevation of 10,023 feet (3,055 m) at its summit on Pu`u `Ula`ula. Near the summit is a volcanic cone known as Kolekole with some of the best astronomy viewing in the world.

The National Science Foundation (NSF) has authorized the development of the Daniel K. Inouye Solar Telescope (DKIST), previously known as the Advanced Technology Solar Telescope (ATST)) within the 18-acre University of Hawai`i Institute for Astronomy High Altitude Observatories (HO) site. The DKIST represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The DKIST project will be the largest and most capable solar telescope in the world. It will be an indispensable tool for exploring and understanding physical processes on the Sun that ultimately affect Earth.

The DKIST Project will be contained within a 0.74 acre site in the HO site. An Environmental Impact Statement was completed for the DKIST project (NSF 2009), and the NSF issued a Record of Decision in December of 2009. The Haleakalā National Park (HALE) Road Corridor is being used for transportation during construction and use of the DKIST. Construction began in December 2012 and was ongoing during the Winter 2017 sampling.

The HO and HALE road corridor contain biological ecosystems that are both unique and fragile. The landscape at HO is considered to be an alpine dry shrub land vegetation type. A diverse fauna of resident insects and spiders reside there (Medeiros and Loope 1994). Some of these arthropods inhabit unique natural habitats on the bare lava flows and cinder cones with limited vegetation. Vegetation covers less than 5% of the open ground, and food is apparently scarce.

The ecosystem at the HO is extremely xeric, caused by relatively low precipitation, porous lava substrates that retain negligible amounts of moisture, little plant cover, and high solar radiation. The dark, heat-absorbing cinder provides only slight protection from the extreme temperatures. Thermal regulation and moisture conservation are critical adaptations of arthropods that occur in this unusual habitat.

An inventory and assessment of the arthropod fauna at the HO site was conducted in 2003 as part of the Long Range Development Plan (LRDP) for the Haleakalā High Altitude Observatories. This inventory and assessment was updated in December 2005 to provide a more detailed description of the arthropod fauna at the two proposed DKIST sites, and identify Hawaiian native arthropod species or habitats, if any, that could be impacted by construction of the DKIST. In an effort to be complete, supplemental sampling was conducted in 2007 to provide a seasonal component and additional nighttime sampling not included in the previous two inventories. Sampling in June 2009 was conducted to establish baseline conditions for future Programmatic Monitoring.

The landscape along the HALE road corridor is classified as alpine and subalpine shrub land habitat zones, depending upon the elevation. These habitats contain several native and non-native species of plants, animals, and arthropods. The subalpine shrub land within the Haleakalā National Park is also host to a wide variety of indigenous arthropod species (Krushelnycky et al. 2007). The vegetation there covers most of the open ground, mostly with native trees and shrubs, with native and alien grasses growing between. Precipitation in the form of rainfall and fog is frequent, with about 70 inches falling throughout the year (Giambelluca et al. 1986).

While the overall impacts on arthropod resources within the Park road corridor during the construction phase would be considered minor, NSF has committed to several mitigation measures to reduce the impacts to these biological resources, including programmatic monitoring for active preservation of invertebrates during and after construction of the DKIST Project.

Environmental monitoring is the scientific investigation of the changes in environmental phenomena, attributes and characteristics that happen over time. Ecosystems are dynamic. Habitat conditions change daily, seasonally, and over longer periods of time. Animal and plant populations rise or fall in response to a host of environmental fluctuations. The general purpose of monitoring is to detect, understand, and predict the biological changes.

The scientific scope of the current phase of Arthropod Monitoring is to repeatedly sample arthropod habitats that may be impacted by construction of the DKIST, document changes to native arthropod populations, and detect new or potentially threatening invasive species

of arthropods that may impact the native resident arthropod fauna. Programmatic Arthropod Monitoring includes identification and taxonomy for both ground and shrub dwellers and is being conducted in both developed and undeveloped areas of HO (excluding the Air Force site)."

Arthropod Programmatic Monitoring consists of one week sampling sessions conducted in the Summer and Winter months using standard arthropod sampling methods similar to those used during the 2007 inventory of arthropods within HALE (Krushelnycky et al. 2007), collecting invertebrates both day and night, with identification and taxonomy for both ground and shrub dwellers in developed and undeveloped portions of the sampling areas.

The primary areas being sampled are the Haleakalā High Altitude Observatories (HO) site on Kolekole Hill, but not including the Air Force site, the DKIST Construction Site, and selected portions of the HALE Road Corridor. The 18 acre HO facility hosts several existing observatories and their support buildings, and also includes several undeveloped sites where native vegetation and the associated arthropod fauna is relatively undisturbed. Although the overall footprint of DKIST is about 0.74 ac, the site where DKIST construction is currently taking place is approximately 0.24-ha (0.6 ac) of previously undisturbed land located east of the existing Mees Solar Observatory facility. The portions of the HALE Road Corridor being sampled are determined in collaboration with the HALE staff biologists at the beginning of each sampling session.

Programmatic Monitoring will provide much of the data needed to protect and enhance natural resources, to modify management actions, to aid in compliance with environmental statutes, and to enhance public education and appreciation of the natural resources at the summit of Haleakalā.

The nomenclature used in this report follows the Hawaiian Terrestrial Arthropod Checklist, Third Edition (Nishida 1997) and the Manual of the Flowering Plants of Hawai'i (Wagner and others 1990). Hawaiian and scientific names are italicized unless major taxonomic revisions were available.

Species Status

Species are discussed as being endemic, indigenous, non-indigenous, adventive, and purposely introduced. These terms are defined as:

Endemic – A species native to, or restricted to Hawai'i.
Indigenous – A species native to Hawai'i but that naturally occurs outside of Hawai'i as well.
Non-indigenous – A species not native to Hawai'i.
Adventive – Not native, a species transported into a new habitat by natural means or accidentally by human activity.
Purposely introduced – A species released in Hawai'i for a particular purpose, usually to control a weedy plant or another insect.

This report describes the results of sampling conducted in April 2017, the first of two sampling sessions for Programmatic Arthropod Monitoring and Assessment this year, and continues monitoring that began in September 2009. The goal is to monitor the arthropod fauna at the HO site, the DKIST construction site, and along the selected portions of the HALE Road Corridor, identify Hawaiian native arthropod species or habitats, if any, that may be impacted by construction of the DKIST, and detect and identify alien invasive arthropod species that could have adverse impacts on the flora and fauna on Haleakalā. Programmatic Arthropod Monitoring studies are being coordinated and conducted with the approval of HALE staff biologists.

Sampling of arthropod habitats was approved in a permit obtained from the Department of Land and Natural Resources (Endorsement Number: I1014), effective date February 1, 2017 – February 1, 2018, and the National Park Service (Permit # HALE-2010-SCI-0001) issued on March 22, 2010. Sampling began on April 8, 2017 and was completed on April 16, 2017.

IV. QUESTIONS OF INTEREST

Important Questions of Interest are those with answers that can be efficiently estimated and that yield the information necessary for management decision-making. The following Questions of Interest were developed for Programmatic Monitoring and the Annual Inspection, and are the focus of this report.

Programmatic Monitoring

Question 1

What are the characteristic arthropod populations at the DKIST site, the larger HO site (excluding the Air Force site), and along selected areas of the HALE Road Corridor?

Justification:

Programmatic Monitoring will yield a comprehensive list of the characteristic arthropod fauna at the DKIST site, developed and undeveloped areas of the HO site, and along selected areas of the HALE Road Corridor.

Monitoring goals:

1) To describe the characteristic arthropod populations at the DKIST site, the larger HO site, and along the HALE Road Corridor,

2) To provide historical records of change in native arthropod species population attributes, and characteristics.

The results of this sampling are combined with information gathered during previous studies to develop a comprehensive list of arthropods at the Haleakalā High Altitude Observatories (HO) site, the DKIST site, and along selected areas of the HALE Road Corridor, and a qualitative description of seasonal variations in their abundance.

Question 2

What adverse impacts can be detected, if any, on characteristic populations of arthropods at the DKIST site, the larger HO site (excluding the Air Force site), and along selected areas of the HALE Road Corridor that may be due to DKIST construction?

Justification:

Programmatic Monitoring of native arthropod species will yield reliable scientific information about the current status (presence and abundance) of these species at the sampling sites. The information will be useful to detect changes and trends that may be due to the construction of the DKIST.

Monitoring goals:

1) To detect changes, trends, periodicities, cycles, and/or other patterns of change in arthropods at the DKIST site, the larger HO site, and along the HALE Road Corridor during the construction of the DKIST.

Programmatic Monitoring reports provide a discussion of the results of sampling, a description of changes in presence or abundance, and an assessment of those changes that may be due to the DKIST construction, and provide opportunities for adaptive management of construction processes, through the use of control measures, where these changes and/or trends negatively affect the arthropod population.

Question 3

What non-indigenous invasive arthropod species, if any, are detected at the DKIST site, the larger HO site (excluding the Air Force site), and along selected areas of the HALE Road Corridor during DKIST construction?

Justification:

Programmatic Monitoring for non-indigenous invasive arthropod species will detect potential threats to the nearby native ecosystems before they have an opportunity to establish resident populations. Early detection will allow implementation of control measures to eradicate invasive arthropod species (e.g. ants and spiders) before they can damage the nearby native ecosystems.

Monitoring goals:

1) To detect non-indigenous invasive arthropod species at the DKIST site, the larger HO site, and along selected areas of the HALE Road Corridor during construction of the DKIST.

If any invasive arthropod species (e.g. ants and spiders) are detected, eradication measures will be implemented to prevent these species from establishing resident populations.

V. METHODS

Site Description

The Haleakalā High Altitude Observatories (HO) site is located on Kolekole Hill. The highest point on the HO site is at 3,052-m (10,012-ft) above sea level. The 7.3-ha (18.1-ac) site was established in 1961, and the first telescope, the Mees Solar observatory was dedicated in 1964. The site now consists of five substantial telescope facilities, in addition to several smaller facilities.

The DKIST site is on undeveloped land located east of the existing Mees Solar Observatory facility at 3,042-m (9,980-ft) above sea level. Annual precipitation averages 1,349.2-mm (53.14-in), falling primarily as rain and mist during the winter months from November through April. Snow rarely falls at the site.

Haleakalā sampling locations were determined with guidance and cooperation from HALE personnel. During this session, sampling was conducted in the area near the HALE Entrance Station, at about 2,072 m (6,800 ft.) on the western slope of Haleakalā.

Monitoring Procedures

The selection of a trapping technique used in this study was carefully considered. When the target species of the trapping system are rare or important for other reasons (i.e., endangered, keystone species, etc.) live-trapping should be considered. Entomologists have long believed that they can sample without an impact on the population being sampled. It has been assumed that collecting has only a small impact on the populations of interest. While this assumption remains to be tested, responsible entomologists consider appropriate trapping techniques to ensure survival of local populations of interest. The sampling methods that were used during this study are similar to those used during the 2007 arthropod inventory conducted on the western slope of Haleakalā (Krushelnycky et al. 2007) and were reviewed by HALE natural resource staff and modified according to their comments.

Pitfall Trapping

After consultation with HALE natural resources staff, ten pitfall traps were installed near HALE Entrance Station site (five below the road and five above the road). Ten pitfall traps were installed at the Astronomy High Altitude

Observatories (HO) site in both developed and undeveloped areas, and ten pitfall traps were deployed at the DKIST site. The traps (300 ml [10 oz.], 80 mm diameter cups) were filled with soapy water solution as preservative. Concerns about endangered native birds precluded the use of ethylene glycol. The traps were spaced at least 2 m apart, and left open for seven days at the DKIST site and for seven days at the HALE site. It was decided that pitfall traps would not be baited around the rim with blended fish because they might attract birds. This is a trapping method similar to that used during an arthropod survey conducted in 2007 (Krushelnycky et al. 2007).

Care was taken to avoid archeological sites. These sites have cultural and historical significance and precautions were made to prevent their disturbance. Traps were not placed in or near these sites. A map of significant historic and cultural sites within 50 feet of the road corridor was used to avoid such sites. Habitat was accessed with a minimum of disturbance. Care was also taken to prevent creation of new trails or evidence of foot traffic.

Care was also taken to avoid disturbing nesting petrels and other wildlife species. The endangered petrels dig into cinder to make burrows for nesting. Efforts were made to avoid known burrows. Pitfall traps are placed below ground and covered with a heavy cap rock. This makes it very unlikely that petrels could access the traps.

All pitfall traps were installed on April 8, 2017 and their contents collected on April 16, 2017.

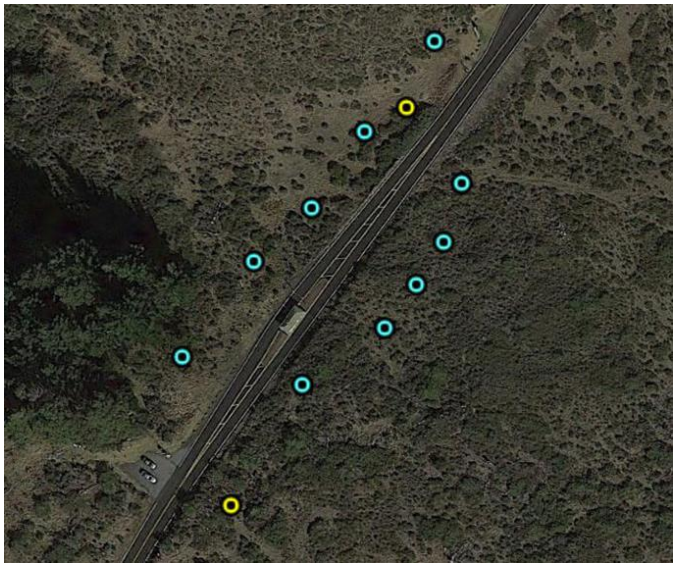
Light-Trapping

Sampling for nocturnal insects is vital to understanding the complete faunal presence. Some insects are only active and moving around at night. Many insects have a nocturnal activity cycle to evade birds, and to locate certain food sources. Night collecting is important in environments like dry locations where insects may choose this strategy to avoid desiccation.

Battery-powered ultraviolet light traps were operated near the HALE Entrance Station, at the HO site, and at the DKIST site. The traps consisted of a 3.5 gallon polypropylene bucket, a smooth surface funnel, a 22 watt Circline blacklight tube mounted on top of vanes under an aluminum lid that directs light downwards. The effective range of the 22 watt lamp is less than 100 feet, and traps were always located more than 100 feet from the nearest petrel burrow. Light traps were run for six nights at the DKIST

site, HO site, and the HALE site. Light traps were set at each sampling site near sunset, and were allowed to run overnight or until batteries failed. An additional night of sampling was suspended due to weather conditions.

Locations of pitfall traps (blue dots) and light traps (yellow dots) at the HO and DKIST Winter 2017.



Locations of pitfall traps (blue dots) and light traps (yellow dots) at the HALE Entrance Station Winter 2017.

Other Light Sampling at Night

Night collecting can be aided by a UV light source. Small handheld ultraviolet blacklights were used for additional sampling for foliage and ground-dwelling arthropods.

Visual Observations and Habitat Collecting Under Rocks and in Leaf Litter

Time was spent sampling under rocks, in leaf litter, and on foliage to locate and collect arthropods at each sampling station. Hand picking, while sorting through leaf litter and bunch grasses, and searching beneath stones was the most effective sampling for litter and soil associated forms.

Collecting on Foliage

Foliage of various common plant species was sampled by beating sheet. A one-meter square beating sheet or insect net was placed under the foliage being sampled and the branch hit sharply three times using a small plastic pipe. After the initial collection the foliage was beaten again to dislodge persistent individuals. Care was taken to avoid sensitive plants and to leave vegetation intact.

Nets

Aerial nets and sweep nets were used as necessary to capture flying insects and arthropods that occur on grasses.

Baited Traps

Baited traps were deployed to detect the presence of ants. These traps consisted of fresh canned tuna placed on an index card and weighted down with a small rock. Traps were set near areas where ants could be introduced or where they may be foraging for food. Baited traps were deployed on the HO and DKIST sites on three different days. The traps were checked after forty-five minutes at which time the traps were be removed. Baited traps were not left open overnight in order to avoid attracting unwanted pests.

On April 9, 2017, fifty baited ant traps were deployed at the HO/DKIST sites and fourteen baited traps were deployed at the HALE ES site.

Inspection of construction lay-down and storage areas

Construction material and equipment in developed lay-down areas were visually inspected for invasive arthropod species and evidence of their presence. Specifically, these areas were inspected for the presence of ants, spiders, spider webs, and indications of the presence of other potentially invasive arthropod species.

Population Estimates

Although NSF committed to "population estimates for developed and undeveloped areas within HO, the DKIST Construction Site, and selected areas of the HALE road corridor" (NSF 2009), population estimates are not possible with the approved sampling techniques. A consultation with the NPS determined that any data collected would be only a snapshot in time, reflective only of the sites sampled, and that the results are seasonal and could not be extrapolated beyond those limits. They also expressed an opinion that any "population estimates" would not be comparable over time and that accurate population estimates for arthropods are not possible with the sampling methods approved for use. In consultation with NPS staff biologists, it was decided that sampling results would be presented as presence/absence, and that qualitative abundance estimates would be a suitable substitute for "population estimates" described in the FEIS (NSF 2009).

Sampling results in this report are presented as presence/absence, and, for selected species, qualitative abundance estimates are substituted for "population estimates" described in the FEIS (NSF 2009).

Relative abundance categories are:

- *infrequent* (individuals captured or observed < 10),
- *uncommon* (10 < individuals captured or observed < 25),
- *common* (25 < individuals captured or observed < 100), and
- *abundant* (100 < individuals captured or observed).

Abundance designations are based exclusively on the capture or observation of specimens encountered at the sampling sites visited during each sampling session, and may be biased against certain species. For example, some ground dwelling species may be under-sampled because traps will not be baited and therefore not attractive to these species. Other species may be more or less abundant at other times of year than those sampled, or not efficiently captured with the sampling methods used. These species may generally be more or less common than indicated from the results. The results presented in reports are only snapshots in time, reflective only of the sites sampled, and the results are seasonal and should not be extrapolated beyond those limits.

Collections

Arthropods that appear in traps were stored and later mounted for identification. Arthropods that are observed during hand collecting and netting were collected only as necessary to provide accurate identification and voucher specimens.

Curation

The contents of the traps were cleaned in 70% ethyl alcohol and placed in vials. The specimens were sorted into the morphospecies for identification. Hard-bodied species, such as beetles, moths, true bugs, flies, and wasps were mounted on pins, either by pinning the specimen or by gluing the specimens to paper points. Pinned specimens were placed into Schmidt boxes. Soft-bodied specimens, such as spiders and caterpillars were stored in vials filled with 70% ethyl alcohol.

Identification

Specimens were mounted and identified to the lowest taxonomic level possible within the time frame of the study. Many small flies and micro-Hymenoptera were sorted to morphospecies and will be sent to reliable experts for identification. Identification of arthropods is difficult, even for experts. More time needs to be allotted for this necessary task in all arthropod inventory projects. All specimen identifications are provisional until they can be confirmed by comparison to museum specimens or by group/taxon experts.

References for general identification of the specimens included *Fauna Hawaiiensis* (Sharp (ed) 1899-1913) and the 17 volumes of *Insects of Hawai'i* (Zimmerman 1948a, 1948b, 1948c, 1948d, 1948e, 1957, 1958a, 1958b, 1978, Hardy 1960, 1964, 1965, 1981, Tentorio 1969, Hardy and Delfinado 1980, Christiansen and Bellinger 1992, Liebherr and Zimmerman 2000, and Daly and Magnacca 2003). Other publications that were useful for general identification included *The Insects and Other Invertebrates of Hawaiian Sugar Cane Fields* (Williams 1931), *Common Insects of Hawai'i* (Fullaway and Krauss 1945), *Hawaiian Insects and Their Kin* (Howarth and Mull 1992), and *An Introduction to the Study of Insects Sixth Edition* (Borror, Triplehorn, and Johnson 1989).

For specific groups specialized keys were necessary. Most of these had to be obtained through library searches. Keys used to identify Heteroptera included those by Usinger (1936, 1942), Ashlock (1966), Beardsley (1966, 1977), Gagné (1997), Polhemus (2002, 2005, 2011, 2014), and Asquith (1994, 1997). Keys used to identify Hymenoptera included

Cushman (1944), Watanabe (1958), Townes (1958), Beardsley (1961, 1969, 1976), Yoshimoto and Ishii (1965), and Yoshimoto (1965a, 1965b).

Species identification of those specimens identified to genus or species levels are unconfirmed and subject to change after comparison to specimens in museums.

In many cases changes in family and generic status and species synonymies caused species names to change from those in the keys. Species names used in this report are those listed in *Hawaiian Terrestrial Arthropod Checklist Third Edition* (Nishida 1997) unless a recent major taxonomic revision was available. Specimens were deposited at the UH Manoa Arthropod Collection.

Schedule/Start and End Dates

Sampling was conducted over eight days and seven nights beginning on April 8, 2017 and ending on April 16, 2017.

VI. RESULTS and DISCUSSION

HIGH ALTITUDE OBSERVATORIES

The HO site covers about 18 acres and contains observatory facilities. Several areas of the site are being used to store materials and equipment. Sixty-nine species of arthropods were detected at the HO site (excluding the Air Force Facility and the DKIST site). The species included seventeen endemic species, thirty-nine non-indigenous species, and thirteen species of unknown status.

Spiders and Mites - Arachnida

Juvenile and adult Lycosid spiders, *Hogna (Lycosa) hawaiiensis* Simon, were common. Small spiders of the family Linyphiidae were uncommon and may represent more than one species. A single specimen from the spider family Theridiidae was observed. This family includes the 'Happy-faced spider' in Hawai'i.

Springtails - Collembola

At least one species of Collembola was observed at the HO site. From the family Entomobryidae, these small insects were uncommon in leaf litter under plants.

Beetles – Order Coleoptera

Thirteen beetle species were observed at the HO site, eleven are non-indigenous.

***Coccinella septempunctata* was abundant on vegetation at the HO site.**

Lady-bird beetles (family Coccinellidae) were the most common beetles at the HO site, represented by nine species. All are non-indigenous species and most are predacious on insects and mites.

Trechus obtusus Erichson, an introduced ground beetle, was uncommon, found under rocks and in pitfall traps. A similar-looking Hawaiian endemic species of *Mecyclothorax* was found infrequently at the HO site.

Two other uncommon non-indigenous beetles were found. These species have been collected at the HO site in past studies.

Flies - Order Diptera

Twelve species of flies were detected at the HO site, none that are known to be native to Hawai'i. These species have been collected in previous sampling efforts. No native fruit flies (genus *Trupanea*) were observed and may have been absent due to seasonal changes in abundance.

True Bugs – Orders Heteroptera and Homoptera

Thirteen species of true bugs (order Heteroptera) were observed including five Hawaiian endemic species. The most abundant true bug at the HO site is *Nysius coenosulus* Stål, an endemic seed bug, which was common on both *Dubautia* and *pukiawe*.

***Pachybrachius nr. fracticollis*, a ground seed bug, is well camouflaged in leaf-litter.**

Species from the family Miridae included the Hawaiian endemic insects *Engytates hawaiiensis* (Kirkaldy) and *Hyalopeplus pelucidus* Stål.

Geocoris pallens Stål were uncommon on vegetation at the HO site. The assassin bug, *Zelus renardii* was an infrequent capture. This bug preys on the bean capsid and has successfully reduced insect damage to crops in Hawai'i.

Six species of Homoptera were found, including an endemic species of plant hopper of the genus *Nesosydne*, abundant on *Dubautia*. Non-indigenous Acacia psyllids, *Acizzia uncatoides* (Ferris & Klyver) were abundant on vegetation at the HO site. An unknown green leafhopper was common also on vegetation.

Bees and Wasps – Order Hymenoptera

Five species of wasps were found at the HO site. Three small parasitic wasps were common around vegetation. Two other small wasps were infrequently observed.

Butterflies and Moths – Order Lepidoptera

Twelve species of Lepidoptera were found at the HO site. These include two endemic species in the genus *Agrotis* and three species of endemic grass moths (family Crambidae). One other endemic moth was observed, Thyrocopa apatela

(Walsingham), the Haleakalā flightless moth. Larvae were found in leaf-litter and adults appeared in pitfall traps. The non-indigenous cabbage looper, *Pieris rapae* (Linnaeus), was common at the HO site.

A complete list of arthropods observed during this sampling session at the HO site can be found in Appendix A at the end of this report. No new invasive species were observed that could impact native arthropod species. The species of indigenous arthropods detected have been observed at the site during other surveys.

DKIST storage and staging site near the FAA facility was clear of wind-blown debris.

DKIST CONSTRUCTION SITE

Construction was started on the DKIST in December 2012 and was ongoing during the Winter 2017 sampling session.

Fifty-eight species of arthropods were collected at the DKIST site during the Winter 2017 sampling session. The species included nineteen endemic Hawaiian arthropods, thirty-one non-indigenous arthropods, and eight species of unknown status.

Spiders and Mites - Arachnida

Lycosid spiders, *Hogna hawaiiensis* Simon, were common. A small Linyphiidae spider was uncommon under rocks.

Endemic Lycosid spiders, *Hogna hawaiiensis*, are common at the DKIST site.

Springtails - Collembola

One species of Collembola was observed at the DKIST site. These small insects were uncommon in leaf litter under plants.

Beetles – Order Coleoptera

Eight species of beetles were observed at the DKIST site, all non-indigenous. The species included six ladybird beetles, a non-indigenous Carabid beetle, and a single specimen of the non-indigenous vegetable weevil, *Listroderes costirostris* Germain was found in litter under *Dubautia*. The latter species is originally from South America, and has spread to many parts of the world including Hawai'i.

Flies - Order Diptera

Twelve species of flies were detected at the DKIST site. Only one endemic species, *Trupanea cratericola* (Grimshaw), was observed. All other fly were common, non-indigenous species observed previously at the DKIST site.

True Bugs – Orders Heteroptera and Homoptera

Nine species of true bugs (Order Heteroptera) were observed at the DKIST site, six endemic to Hawai'i. *Nysius coenosulus* Stål was the most common true bug at the DKIST site, occurring on vegetation. Another endemic true bug, *N. lichenicola* Kirkaldy, was uncommon in leaf litter under plants.

Three other Hawaiian endemic species include the abundant *Engytates hawaiiensis* (Kirkaldy) and infrequent *Hyalopeplus pelucidus* Stål. Both are known from other Hawaiian Islands. Two other endemic species were collected at the DKIST site, *Trigonotylus hawaiiensis* (Kirkaldy), found on grasses and *Nysius communis* Usinger, on vegetation at the DKIST site.

Five species of Homoptera were collected, including a species of the endemic genus Nesosydne that was abundant on Dubautia, Non-indigenous species include a green planthopper common on *pukiawe* and the abundant Acacia psyllid.

Acacia psyllids are abundant on *Dubautia* at the DKIST site.

Bees and Wasps – Order Hymenoptera

Seven species of bees and wasps were observed at the DKIST site. These species include three species of endemic yellow-faced bees, small parasitic wasps and honey bees. No ants were found at the DKIST site.

Moths – Order Lepidoptera

Nine species of Lepidoptera were collected, six endemic species and three non-indigenous species. Two large moths in the genus *Agrotis* were captured in light traps. Caterpillars of the genus *Agrotis* were found in pitfall traps. Larvae of the Haleakalā flightless moth (*Thyrocopa apatela* (Walsingham)) were frequently observed in leaf litter and two adults were captured in pitfall traps.

Non-indigenous white cabbage butterflies (*Pieris rapae* (Linnaeus)) were common flying around the DKIST site on sunny days.

A complete list of arthropods observed during this sampling session at the DKIST site can be found in Appendix B at the end of this report. No new invasive species were observed that could impact native arthropod species.

HALEAKALĀ ENTRANCE STATION

Sampling in Haleakalā National Park occurred near the park Entrance Station (HALE ES) at 6,250 feet elevation. Ninety-six species of arthropods were collected and observed there. The species included thirty-four endemic Hawaiian arthropods, forty-two non-indigenous arthropods, and twenty species of unknown status.

Spiders and Mites - Arachnida

Six species of spiders were recorded at the HALE ES site. The only species identified as endemic was a crab spider (*Mecaphesa sp. nr. kanakanus* (Karsch)), uncommon on vegetation.

The non-indigenous Garden Sac spider (*Cheiracanthium mordax* L. Koch) was common in sweep net sampling over grasses. The False Black Widow spider (*Steatoda grossa* (C. L. Koch)) was common under rocks and in low-growing vegetation. This spider is similar in appearance to the black widow, lacking the red hourglass pattern on the underside of the abdomen. Both of these species have been reported from HALE in the past. The endemic crab spider, *Mecaphesa kanakanus*, was uncommon at HALE ES. This species is known from Haleakalā above 7,000 ft. (2,100 m) (Suman 1967).

Two species of mites of unknown status were also observed.

Collembola - Springtails

One species of Collembola was observed at the HALE ES site. These small insects were common in leaf litter under plants and in pitfall traps.

Beetles – Order Coleoptera

Nine species of beetles were observed, including an endemic ground beetle (genus *Mecyclothorax*) and a similar-looking, but somewhat smaller, non-indigenous ground beetle, *Trechus obtusus* Erichson.

Trechus obtusus Erichson, an uncommon resident of the habitat near the HALE ES.

Specimens of the Apple Weevil, *Otiorhynchus cribricollis*, was uncommon at the site. Other non-indigenous beetles include two species of ladybird beetles and two specimens of a very small

unidentified Carabid beetle collected under rocks.

Flies – Order Diptera

Eleven species of flies were seen at the HALE ES. Seven species were from families of common non-indigenous flies (e.g.: blow flies, and bee flies) previously reported from HALE ES. Four species were of unknown status.

True Bugs – Orders Heteroptera and Homoptera

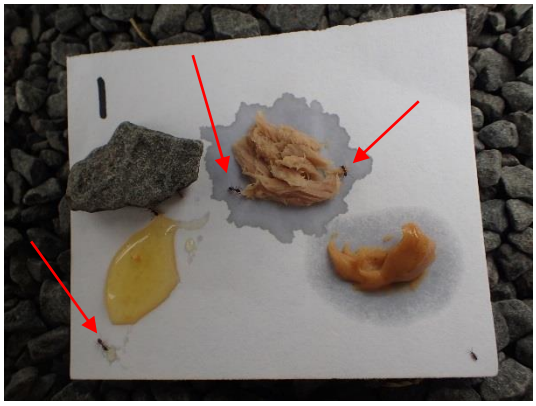
Eleven species of true bugs (Heteroptera) were found. Endemic Hawaiian species include two seed bugs, two common species of small green plant bugs of the genus *Orthotylus*, and two species of plant bugs from the genus *Sarona* one pale-orange in color found on *mamane*.

The non-indigenous Hyaline Grass Bug, *Liorhyssus hyalinus*, occurred infrequently and the non-indigenous *Pachybrachius nr. fracticollis*, was uncommon at the HALE ES.

Six species of Homoptera were observed, including three Hawaiian endemic species of *Nesophrosyne* (family Cicadellidae), that were common on vegetation.

Bees and Wasps – Order Hymenoptera

The nine species of Hymenoptera found near the HALE Entrance Station included two species of endemic yellow-faced bee (genus *Hylaeus*), honey bees, two non-indigenous wasps, and an unknown parasitoid.



Red arrows point to Argentine ants on ant bait card at HALE ES.

Three ants were found. The Argentine ant, *Linepithema humile*, the Tramp ant, *Cardiocondyla kagutsuchi/venestula*, and *Hypoponera opaciceps*, all previously known from the HALE ES. The latter species is also known from upper elevations in the park where it forms small colonies (Krushelnycky et al. 2007).

Butterflies and Moths – Order Lepidoptera

Thirty-two species of Lepidoptera were observed at the HALE ES, nineteen endemic to Hawai'i. Common endemics include small moths from the

Carposinidae, Cosmopterigidae, Crambidae families, and larger moths from the Geometridae and Noctuidae families.

The most common non-indigenous species included two large noctuid moths, *Agrotis ipsilon* (Hufnagel) and *Pseudaletia unipunctata* (Haworth), and the lantana biocontrol moth, *Stenoptilodes littoralis rhynchophora* (Meyrick).

Other Observations

Other arthropods were observed at the HALE ES, including centipedes, millipedes, and sowbugs common in pitfall traps, under rocks, and in decaying vegetation. A single specimen of the non-indigenous cricket, *Trigonidomorpha sjostedti* Chopard was collected as well.

A complete list of arthropods observed during this sampling session at the HALE ES site can be found in Appendix C at the end of this report. No new invasive species were observed that could impact native arthropod species.

Discussion

The arthropods that were found during this sampling are characteristic of the fauna found during previous monitoring. No new invasive arthropods were detected at the DKIST site, the larger HO site, and HALE ES sites.

No trends in populations were detected beyond normal seasonal variation and weather related abundance. The species reported are reflective only of the sites sampled, and only qualitative data of abundance were taken.

There are three main Questions of Interest that are to be answered by this monitoring:

Question 1

What are the characteristic arthropod populations at the DKIST site, the larger HO site (excluding the Air Force site), and along selected areas of the HALE Road Corridor?

The Characteristic arthropods found at the monitored sites can be found in the species lists in the appendices at the end of this report.

Question 2

What adverse impacts can be detected, if any, on characteristic populations of arthropods at the DKIST site, the larger HO site (excluding the Air Force site), and along selected areas of the HALE Road Corridor that may be due to DKIST construction?

There have been minor adverse impacts on indigenous arthropod species at the monitored sites. Native vegetation was removed from the construction site during site excavation. This reduced the size of the arthropod population at the site, however, vegetation is already recovering and it can be expected that native arthropods will return to the site to exploit the renewed plant resources.

Question 3

What non-indigenous invasive arthropod species, if any, are detected at the DKIST site, the larger HO site (excluding the Air Force site), and along selected areas of the HALE Road Corridor during DKIST construction?

There were no invasive non-indigenous arthropod species detected at the HO and DKIST sites. No new invasive arthropod species were discovered at the HALE ES site, the species observed there have been detected in previous sampling sessions.

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APPENDIX A
HO ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the Winter 2017 sampling at the HO site.

Class	Order	Family	Genus	Species	Authority	Status	Abundance
Arachnida	Araneae	Lycosidae	Hogna	hawaiiensis	Simon	endemic	C
Arachnida	Araneae	Linyphiidae				unknown	U
Arachnida	Araneae	Theridiidae				unknown	U
CHILOPODA	Lithobiomorpha					unknown	U
Collembola	Entomobryidae					endemic	U
Crustacea	Isopoda	Porcellionidae	Porcellio	scaber	Latreille	non-indigenous	I
Gastropoda	Stylommatophora	Zonitidae	Oxychilus	alliarius	(J.S. Miller)	non-indigenous	U
Insecta	Coleoptera	Carabidae	Mecyclothorax	spp.		endemic	I
Insecta	Coleoptera	Carabidae	Trechus	obtusus	Erichson	non-indigenous	U
Insecta	Coleoptera	Chrysomelidae	Altica	carinata	(Germar)	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Coccinella	californica	(Mannerheim)	non-indigenous	I
Insecta	Coleoptera	Coccinellidae	Coccinella	septempunctata	Linnaeus	non-indigenous	A
Insecta	Coleoptera	Coccinellidae	Cryptolaemus	montrouzieri	Mulsant	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Diomus	notescens	(Blackburn)	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Harmonia	conformis	(Boisduval)	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Hippodemia	convergens	Gurein-Meneville	non-indigenous	I
Insecta	Coleoptera	Coccinellidae	Olla	v-nigrum	(Mulsant)	non-indigenous	C
Insecta	Coleoptera	Coccinellidae	Rhyzobius	forestieri	(Mulsant)	non-indigenous	I
Insecta	Coleoptera	Coccinellidae	Rhyzobius	lophanthae	(Blaisdale)	non-indigenous	I
Insecta	Coleoptera	Staphylinidae				unknown	U
Insecta	Diptera	Anthomyiidae	Delia	platura	(Meigen)	non-indigenous	U
Insecta	Diptera	Calliphoridae	Calliphora	latifrons	Hough	non-indigenous	C
Insecta	Diptera	Calliphoridae	Calliphora	vomitoria	(Linnaeus)	non-indigenous	C
Insecta	Diptera	Chamaemyiidae	Leucopis	albipuncta	Zetterstedt	non-indigenous	C
Insecta	Diptera	Drosophilidae	Drosophila	melanogaster	Meigen	non-indigenous	U
Insecta	Diptera	Sarcophagidae				non-indigenous	U
Insecta	Diptera	Sepsidae	Sepsis	thoracica	(Robineau-Desvoidy)	non-indigenous	C
Insecta	Diptera	Syrphidae	Allograpta	exotica	(Weidemann)	non-indigenous	U
Insecta	Diptera	Syrphidae	Eristalis	tenax	(Linneaus)	non-indigenous	U
Insecta	Diptera	Drosophilidae				unknown	I
Insecta	Diptera	Muscidae				unknown	C
Insecta	Diptera	Tipulidae	SP1			unknown	I
Insecta	Heteroptera	Lygaeidae	Nysius	coenosulus	Stål	endemic	C
Insecta	Heteroptera	Lygaeidae	Nysius	communis	Usinger	endemic	U
Insecta	Heteroptera	Lygaeidae	Nysius	palor	Ashlock	endemic	I
Insecta	Heteroptera	Miridae	Engytates	hawaiiensis	(Kirkaldy)	endemic	A
Insecta	Heteroptera	Miridae	Hyalopeplus	pelucidus	Stål	endemic	I
Insecta	Heteroptera	Geocoridae	Geocoris	pallens	Stål	non-indigenous	U
Insecta	Heteroptera	Lygaeidae	Pachybrachius	nr. fracticollis		non-indigenous	U
Insecta	Heteroptera	Miridae	Coridromius	variegatus	(Montrouzier)	non-indigenous	I

Class	Order	Family	Genus	Species	Authority	Status	Abundance
Insecta	Heteroptera	Nabidae	Nabis	capsiformis	Germar	non-indigenous	I
Insecta	Heteroptera	Reduviidae	Zelus	renardii	Kolenati	non-indigenous	I
Insecta	Heteroptera	Rhyparochromidae	Brentiscerus	putoni	(White)	non-indigenous	U
Insecta	Heteroptera	Anthocoridae				unknown	I
Insecta	Heteroptera	Nabidae				unknown	I
Insecta	Homoptera	Delphacidae	Nesosydne	sp.		endemic	A
Insecta	Homoptera	Aphididae	SP1			non-indigenous	U
Insecta	Homoptera	Cercopidae	Clastoptera	xanthocephala	Germar	non-indigenous	I
Insecta	Homoptera	Cicadellidae	Draeculacephala	minerva	Ball	non-indigenous	I
Insecta	Homoptera	Psyllidae	Acizzia	uncatoides	(Ferris & Klyver)	non-indigenous	A
Insecta	Homoptera	Cicadellidae	SP1			unknown	C
Insecta	Hymenoptera	Ichneumonidae	Barichneumon	californicus	(Ashmead)	non-indigenous	I
Insecta	Hymenoptera	Ichneumonidae	Gelis	tenellus	(Say)	non-indigenous	C
Insecta	Hymenoptera	Ichneumonidae	Spilichneumon	superbus	(Provancher)	non-indigenous	I
Insecta	Hymenoptera	Braconidae				unknown	C
Insecta	Hymenoptera	Eulophidae				unknown	C
Insecta	Lepidoptera	Crambidae	Eudonia	spp.		endemic	U
Insecta	Lepidoptera	Crambidae	Omiodes	continuatalis	(Wallengren)	endemic	I
Insecta	Lepidoptera	Crambidae	Omiodes	monogona	Meyrick	endemic	I
Insecta	Lepidoptera	Lycaenidae	Udara	blackburni	(Tuely)	endemic	I
Insecta	Lepidoptera	Noctuidae	Agrotis	baliopa	Meyrick	endemic	U
Insecta	Lepidoptera	Noctuidae	Agrotis	epicremna	Meyrick	endemic	C
Insecta	Lepidoptera	Noctuidae	larva			endemic	U
Insecta	Lepidoptera	Xyloryctidae	Thyrocopa	apatela	(Walsingham)	endemic	U
Insecta	Lepidoptera	Lycaenidae	Lampides	boeticus	(Linnaeus)	non-indigenous	U
Insecta	Lepidoptera	Noctuidae	Agrotis	ipsilon	(Hufnagel)	non-indigenous	I
Insecta	Lepidoptera	Nymphalidae	Vanessa	cardui	(Linnaeus)	non-indigenous	I
Insecta	Lepidoptera	Pieridae	Pieris	rapae	(Linnaeus)	non-indigenous	C
Insecta	Psocoptera					unknown	C

APPENDIX B
DKIST ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the Winter 2017 sampling at the DKIST site.

Class	Order	Family	Genus	Species	Authority	Status	Abundance
Arachnida	Araneae	Linyphiidae				unknown	U
Arachnida	Araneae	Lycosidae	Hogna	hawaiiensis	Simon	endemic	C
CHILOPODA	Lithobiomorpha					unknown	U
Collembola	Entomobryidae					endemic	U
Crustacea	Isopoda	Porcellionidae	Porcellio	scaber	Latreille	non-indigenous	I
Gastropoda	"Slugs"					non-indigenous	I
Insecta	Coleoptera	Carabidae	Trechus	obtusus	Erichson	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Coccinella	californica	(Mannerheim)	non-indigenous	I
Insecta	Coleoptera	Coccinellidae	Coccinella	septempunctata	Linnaeus	non-indigenous	A
Insecta	Coleoptera	Coccinellidae	Diomus	notescens	(Blackburn)	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Harmonia	conformis	(Boisduval)	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Olla	v-nigrum	(Mulsant)	non-indigenous	C
Insecta	Coleoptera	Coccinellidae	Rodolia	cardinalis	(Mulsant)	non-indigenous	I
Insecta	Coleoptera	Curculionidae	Listroderes	difficilis	Germain	non-indigenous	I
Insecta	Diptera	Anthomyiidae	Delia	platura	(Meigen)	non-indigenous	U
Insecta	Diptera	Calliphoridae	Calliphora	latifrons	Hough	non-indigenous	C
Insecta	Diptera	Calliphoridae	Calliphora	vomitoria	(Linnaeus)	non-indigenous	C
Insecta	Diptera	Chamaemyiidae	Leucopis	albipuncta	Zetterstedt	non-indigenous	C
Insecta	Diptera	Drosophilidae	Drosophila	melanogaster	Meigen	non-indigenous	U
Insecta	Diptera	Muscidae				unknown	C
Insecta	Diptera	Sarcophagidae				non-indigenous	U
Insecta	Diptera	Sepsidae	Sepsis	thoracica	(Robineau-Desvoidy)	non-indigenous	C
Insecta	Diptera	Syrphidae	Allograpta	exotica	(Weidemann)	non-indigenous	U
Insecta	Diptera	Syrphidae	Eristalis	tenax	(Linneaus)	non-indigenous	U
Insecta	Diptera	Syrphidae	Toxomerus	marginatus	(Say)	non-indigenous	U
Insecta	Diptera	Tephritidae	Trupanea	cratericola	(Grimshaw)	endemic	I
Insecta	Heteroptera	Lygaeidae	Nysius	coenosulus	Stål	endemic	C
Insecta	Heteroptera	Lygaeidae	Nysius	communis	Usinger	endemic	U
Insecta	Heteroptera	Lygaeidae	Nysius	lichenicola	Kirkaldy	endemic	I
Insecta	Heteroptera	Lygaeidae	Pachybrachius	nr. fracticollis		non-indigenous	U
Insecta	Heteroptera	Miridae	Engytates	hawaiiensis	(Kirkaldy)	endemic	A
Insecta	Heteroptera	Miridae	Hyalopeplus	pelucidus	Stål	endemic	I
Insecta	Heteroptera	Miridae	Trigonotylus	hawaiiensis	(Kirkaldy)	endemic	I
Insecta	Heteroptera	Rhopalidae	Liorhyssus	hyalinus	(Fabricius)	non-indigenous	I
Insecta	Heteroptera	Rhyparochromidae	Brentiscerus	putoni	(White)	non-indigenous	U
Insecta	Homoptera	Aphididae	SP1			non-indigenous	U
Insecta	Homoptera	Cicadellidae	SP1			unknown	C
Insecta	Homoptera	Delphacidae	Nesosydne	sp.		endemic	A
Insecta	Homoptera	Pseudococcidae	SP 1			unknown	I
Insecta	Homoptera	Psyllidae	Acizzia	uncatoides	(Ferris & Klyver)	non-indigenous	A

Class	Order	Family	Genus	Species	Authority	Status	Abundance
Insecta	Hymenoptera	Apidae	Apis	mellifera	Linneaus	non-indigenous	I
Insecta	Hymenoptera	Braconidae				unknown	C
Insecta	Hymenoptera	Colletidae	Hylaeus	nivicola	Meade-Waldo	endemic	C
Insecta	Hymenoptera	Colletidae	Hylaeus	sp.		endemic	C
Insecta	Hymenoptera	Colletidae	Hylaeus	volcanicus	(Perkins)	endemic	I
Insecta	Hymenoptera	Eulophidae				unknown	C
Insecta	Hymenoptera	Ichneumonidae	Gelis	tenellus	(Say)	non-indigenous	C
Insecta	Lepidoptera	Crambidae	Omiodes	monogona	Meyrick	endemic	I
Insecta	Lepidoptera	Lycaenidae	Lampides	boeticus	(Linnaeus)	non-indigenous	U
Insecta	Lepidoptera	Lycaenidae	Udara	blackburni	(Tuely)	endemic	I
Insecta	Lepidoptera	Noctuidae	Agrotis	baliopa	Meyrick	endemic	U
Insecta	Lepidoptera	Noctuidae	Agrotis	epicremna	Meyrick	endemic	C
Insecta	Lepidoptera	Noctuidae	larva			endemic	U
Insecta	Lepidoptera	Noctuidae	Pseudaletia	unipunctata	(Haworth)	non-indigenous	U
Insecta	Lepidoptera	Pieridae	Pieris	rapae	(Linnaeus)	non-indigenous	C
Insecta	Lepidoptera	Xyloryctidae	Thyrocopa	apatela	(Walsingham)	endemic	U
Insecta	Neuroptera	Hemerobiidae	Hemerobius	pacificus	Banks	non-indigenous	I
Insecta	Psocoptera					unknown	C

APPENDIX C
HALE ES ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the Winter 2017 sampling at the HALE Entrance Station.

Class	Order	Family	Genus	Species	Authority	Status	Abundance
Arachnida	Acari		SP1			unknown	U
Arachnida	Acari		SP2			unknown	U
Arachnida	Araneae	Thomisidae	Mecaphesa	sp. nr. kanakanus	(Karsch)	endemic	U
Arachnida	Araneae	Clubionidae	Cheiracanthium	mordax	L. Koch	non-indigenous	C
Arachnida	Araneae	Theridiidae	Steatoda	grossa	(C. L. Koch)	non-indigenous	C
Arachnida	Araneae	Linyphiidae				unknown	U
Arachnida	Araneae	Salticidae				unknown	U
Arachnida	Araneae	Theridiidae				unknown	C
CHILOPODA	Lithobiomorpha					unknown	C
Collembola	Entomobryidae					endemic	C
Crustacea	Isopoda	Porcellionidae	Porcellio	scaber	Latreille	non-indigenous	C
DIPLOPODA	Julida	Allajulus	latistriatus		(Curtis)	non-indigenous	A
Gastropoda	"Slugs"					non-indigenous	C
Gastropoda	Stylommatophora	Zonitidae	Oxychilus	alliarius	(J.S. Miller)	non-indigenous	C
Insecta	Coleoptera	Carabidae	Mecyclothorax	spp.		endemic	I
Insecta	Coleoptera	Apionidae	Exapion	ulicis	(Forster)	non-indigenous	I
Insecta	Coleoptera	Carabidae	Trechus	obtusus	Erichson	non-indigenous	U
Insecta	Coleoptera	Coccinellidae	Cryptolaemus	montrouzieri	Mulsant	non-indigenous	I
Insecta	Coleoptera	Coccinellidae				non-indigenous	I
Insecta	Coleoptera	Curculionidae	Otiorhynchus	cribricollis	Gyllenhal	non-indigenous	U
Insecta	Coleoptera	Carabidae				unknown	I
Insecta	Coleoptera	Ptiliidae				unknown	I
Insecta	Coleoptera	Staphylinidae				unknown	U
Insecta	Dermaptera	Forficulidae	Forficula	auricularia	Linnaeus	non-indigenous	C
Insecta	Diptera	Anthomyiidae	Delia	platura	(Meigen)	non-indigenous	U
Insecta	Diptera	Calliphoridae	Calliphora	vomitoria	(Linnaeus)	non-indigenous	C
Insecta	Diptera	Chamaemyiidae	Leucopis	albipuncta	Zetterstedt	non-indigenous	U
Insecta	Diptera	Drosophilidae	Drosophila	melanogaster	Meigen	non-indigenous	U
Insecta	Diptera	Sepsidae	Sepsis	thoracica	(Robineau-Desvoidy)	non-indigenous	C
Insecta	Diptera	Syrphidae	Allograpta	exotica	(Weidemann)	non-indigenous	U
Insecta	Diptera	Syrphidae	Toxomerus	marginatus	(Say)	non-indigenous	U
Insecta	Diptera	Drosophilidae				unknown	I
Insecta	Diptera	Muscidae				unknown	C
Insecta	Diptera	Sciaridae				unknown	C
Insecta	Diptera	Tipulidae	SP1			unknown	C
Insecta	Heteroptera	Lygaeidae	Nysius	coenosulus	Stål	endemic	U
Insecta	Heteroptera	Lygaeidae	Nysius	palor	Ashlock	endemic	I

Class	Order	Family	Genus	Species	Authority	Status	Abundance
Insecta	Heteroptera	Miridae	Hyalopeplus	pelucidus	Stål	endemic	I
Insecta	Heteroptera	Miridae	Orthotylus	coprosmaphila	Polhemus	endemic	C
Insecta	Heteroptera	Miridae	Orthotylus	sophoriodes	Polhemus	endemic	C
Insecta	Heteroptera	Miridae	Sarona	sp.		endemic	C
Insecta	Heteroptera	Miridae	Sarona	sp. 2		endemic	I
Insecta	Heteroptera	Lygaeidae	Pachybrachius	nr. fracticollis		non-indigenous	U
Insecta	Heteroptera	Rhopalidae	Liorhyssus	hyalinus	(Fabricius)	non-indigenous	I
Insecta	Heteroptera	Rhyparochromidae	Brentiscerus	putoni (= australis)	(White)	non-indigenous	U
Insecta	Heteroptera	Miridae	SP1			unknown	I
Insecta	Homoptera	Cicadellidae	Nesophrosyne	sp. 1		endemic	C
Insecta	Homoptera	Delphacidae	Nesosydne	sp.		endemic	C
Insecta	Homoptera	Delphacidae	Nesosydne	sp. 2		endemic	A
Insecta	Homoptera	Aphididae	SP1			non-indigenous	C
Insecta	Homoptera	Psyllidae	Acizzia	uncatoides	(Ferris & Klyver)	non-indigenous	C
Insecta	Homoptera	Pseudococcidae	SP 1			unknown	U
Insecta	Hymenoptera	Colletidae	Hylaeus	sp.		endemic	U
Insecta	Hymenoptera	Colletidae	Hylaeus	volatilis	(F. Smith)	endemic	I
Insecta	Hymenoptera	Apidae	Apis	mellifera	Linneaus	non-indigenous	C
Insecta	Hymenoptera	Formicidae	Cardiocondyla	kagutsuchi/venestula		non-indigenous	I
Insecta	Hymenoptera	Formicidae	Hypoponera	opaciceps	(Mayr)	non-indigenous	U
Insecta	Hymenoptera	Formicidae	Linepithema	humile	(Mayr)	non-indigenous	U
Insecta	Hymenoptera	Vespidae	Polistes	aurifer	de Saussure	non-indigenous	I
Insecta	Hymenoptera	Vespidae	Vespula	pensylvanica	(Saussure)	non-indigenous	I
Insecta	Hymenoptera	Braconidae				unknown	C
Insecta	Lepidoptera	Carposinidae	Carposina	sp. A		endemic	C
Insecta	Lepidoptera	Carposinidae	Carposina	sp. B		endemic	U
Insecta	Lepidoptera	Cosmopterigidae	Hyposmocoma	sp.1		endemic	C
Insecta	Lepidoptera	Crambidae	Eudonia	spp.		endemic	U
Insecta	Lepidoptera	Crambidae	Omiodes	monogona	Meyrick	endemic	U
Insecta	Lepidoptera	Crambidae	Orthomecyna	sp.		endemic	C
Insecta	Lepidoptera	Crambidae	Udea	heterodoxa	(Meyrick)	endemic	I
Insecta	Lepidoptera	Crambidae	Udea	pyranthes	(Meyrick)	endemic	C
Insecta	Lepidoptera	Crambidae	Uresiphita	polygonalis	(Butler)	endemic	U
Insecta	Lepidoptera	Geometridae	Eupithecia	monticolans	Butler	endemic	C
Insecta	Lepidoptera	Geometridae	Eupithecia	sp.		endemic	C
Insecta	Lepidoptera	Geometridae	Scotorythra	paludicola	(Butler)	endemic	I
Insecta	Lepidoptera	Geometridae	Scotorythra	rara	(Butler)	endemic	C
Insecta	Lepidoptera	Geometridae	Scotorythra	sp.		endemic	C
Insecta	Lepidoptera	Noctuidae	Agrotis	baliopa	Meyrick	endemic	U
Insecta	Lepidoptera	Noctuidae	Agrotis	epicremna	Meyrick	endemic	U
Insecta	Lepidoptera	Noctuidae	Agrotis	giffardi (or mesotoxa)		endemic	I
Insecta	Lepidoptera	Noctuidae	Agrotis	xiphias	Meyrick	endemic	C
Insecta	Lepidoptera	Torticidae	Cydia	sp. 1		endemic	U
Insecta	Lepidoptera	Crambidae	Spoladea	recurvalis	(Fabricius)	non-indigenous	I
Insecta	Lepidoptera	Lycaenidae	Lampides	boeticus	(Linnaeus)	non-indigenous	I

Class	Order	Family	Genus	Species	Authority	Status	Abundance
Insecta	Lepidoptera	Noctuidae	Agrotis	ipsilon	(Hufnagel)	non-indigenous	C
Insecta	Lepidoptera	Noctuidae	Athetis	thoracica	(Moore)	non-indigenous	U
Insecta	Lepidoptera	Noctuidae	Chrysodeixis	eriosoma	(Doubleday)	non-indigenous	U
Insecta	Lepidoptera	Noctuidae	Megalographa	biloba	(Stephens)	non-indigenous	U
Insecta	Lepidoptera	Noctuidae	Pseudaletia	unipunctata	(Haworth)	non-indigenous	C
Insecta	Lepidoptera	Nymphalidae	Vanessa	cardui	(Linnaeus)	non-indigenous	I
Insecta	Lepidoptera	Pieridae	Pieris	rapae	(Linnaeus)	non-indigenous	C
Insecta	Lepidoptera	Pterophoridae	Stenoptilodes	littoralis	(Meyrick)	non-indigenous	C
Insecta	Lepidoptera	Microlepidoptera	SP1			unknown	C
Insecta	Lepidoptera	Noctuidae	Hypena	sp.		unknown	U
Insecta	Lepidoptera	Tortricidae				unknown	U
Insecta	Neuroptera	Hemerobiidae	Hemerobius	pacificus	Banks	non-indigenous	U
Insecta	Orthoptera	Gryllidae	Trigonidomorpha	sjostedti	Chopard	non-indigenous	I
Insecta	Psocoptera					unknown	C