

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

August 2014

Prepared for

**K.C. Environmental, Inc.
P.O. Box 1208
Makawao, HI 96768
(808) 573-1903**



Pacific Analytics, L.L.C.

**35891 Richardson Gap Road
Scio, Oregon 97374
(541) 258-5919
*www.statpros.com***

Prepared by:

Pacific Analytics, L.L.C.
35891 Richardson Gap Road
Scio, Oregon 97374
Tel. (541) 258-5919
mail@statpros.com
www.statpros.com

Gregory Brenner
Senior Associate / Project Manager

The pictures contained in this report are for the exclusive use by Pacific Analytics, L.L.C and its clients. All photographs are copyrighted by Pacific Analytics, L.L.C. and may not be reproduced or used without the express written permission of Pacific Analytics, L.L.C.

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

I. TABLE OF CONTENTS

	Page
I. TABLE OF CONTENTS	1
II. EXECUTIVE SUMMARY	2
III. INTRODUCTION	4
IV. QUESTIONS OF INTEREST	8
V. METHODS	11
VI. RESULTS AND DISCUSSION	17
VII. LITERATURE CITED	24
APPENDIX A HO ARTHROPOD SPECIES LIST	29
APPENDIX B DKIST ARTHROPOD SPECIES LIST	30
APPENDIX B HALE ES ARTHROPOD SPECIES LIST	31

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 operation 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 shrubland vegetation type and resources along the Park road corridor are grouped into alpine and subalpine shrubland 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 proposed DKIST Project.

After some preliminary sampling near the HALE Entrance Station 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, and occurred prior to start of construction in 2011 and 2012, and during construction in 2013 and 2014.

This report presents the results of the summer 2014 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

III. INTRODUCTION

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 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. Construction began in December 2012 and was ongoing during the summer 2014 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 shrubland 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.

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 are the focus of this report.

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 Astronomy 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 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 a cinder and lava cone known as Kolekole Hill. The site is at 3,052-m (10,012-ft) above sea level, adjacent to Pu`u `Ula`ula, also known as Red Hill, the highest elevation on Maui, 3,055-m (10,023-ft). 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. 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.

Sampling locations within HALE were identified 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.

Procedures

The selection of a trapping technique used in a 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 and were reviewed by HALE natural resource staff and modified according to their comments.

other potentially invasive arthropod species.

Population Estimates

Although NSF committed to establishing “population estimates for developed and undeveloped areas within HO, the DKIST Construction Site, and selected areas of the HALE road corridor” (NSF 2009), they are not possible to obtain 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. In their 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).

Therefore, 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).

It should be noted that 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

Specimens were stored and later mounted for identification. Arthropods

VI. RESULTS and DISCUSSION

HO SITE

The HO site covers about 18.1 acres and contains five observatory facilities. Several areas of the site are currently being used to store materials and equipment for DKIST construction. Thirty-one species of arthropods were detected at the HO site (excluding the Air Force Facility and the DKIST site). The species included fourteen endemic species, nine non-indigenous species, and eight of unknown status.



A lycosid spider observed foraging on rocks.

Spiders -Araneae

Juvenile and adult Lycosid spiders, *Lycosa hawaiiensis* Simon, were common, actively foraging among rocks and cinders. They also occurred in pitfall traps, where they were uncommon.

These spiders have been observed in nests of small pebbles held together with silken threads.

The presence and abundance of Lycosid spiders have been consistent at HO since I started sampling there in 2003. They are commonly observed throughout the HO site, and telescope construction has apparently not impacted the relative abundance of this species. However, it is possible that the overall absolute number contained within the HO site may be smaller than it was before any manmade structures were in place, since observatory footprints reduce habitat availability.

Small mites were uncommon in pitfall traps. Their identity and status is unknown. They have been observed during many previous sampling sessions at HO.

Beetles - Order Coleoptera

Four beetle species were observed at the HO site, including three non-indigenous lady bird beetles (*Hippodamia convergens* Guerin-Meneville, *Olla v-nigrum* (Mulsant), and *Coccinella septempunctata*

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

Linnaeus). These three species were uncommon at the site, occurring on vegetation. The fourth species was an endemic longhorn beetle, (*Plagithmysus dubautianus* Gressit and Davis). Only one specimen of this infrequently occurring species was found.

Collembola - Springtails

At least one species of Collembola was observed at the HO site. These small insects were common in leaf litter under plants.

Flies - Order Diptera

Ten species of flies were detected at the HO site. The non-indigenous species included blowflies, small muscids, a large tachinid, a fruit fly, and a syrphid. Two specimens of native fruit flies (*Trupanea* sp.) were found. Also observed for the first time since Arthropod Programmatic Monitoring began were endemic long-legged flies (family Dolichopodidae). These metallic green flies were observed on *pukiawe*, and were likely blown up the mountain by the recent strong winds.

True Bugs - Orders Heteroptera and Homoptera

Five species of bugs (Heteroptera) were observed including adults and nymphs of three Hawaiian endemic species in the genus *Nysius*. The others were endemic

plant bugs of the family Miridae. Like the Lycosid spider, these true bugs are some of the most consistently occurring insects found at the HO site.

Two other species of bugs were detected, including hoppers of the genus *Nesosydne*. Adults and nymphs of this genus of endemic plant hoppers were abundant on *Dubautia* plants. The other species was a leafhopper (family Cicadellidae) of unknown status.

Bees and Wasps - Order Hymenoptera

Only one species of Hymenoptera was observed at the HO site during this monitoring session, a small parasitic wasp of the family Eurytomidae. Only one specimen was found. It was in a pitfall trap.

Missing during this sampling season were the endemic yellow-faced bees. Their abundance was low during the last monitoring session, but they were abundant in previous samplings. It is likely their abundance is seasonal, because they were also missing at the HALE entrance station.

Butterflies and Moths - Order Lepidoptera

Five species Lepidoptera were found at the HO site.

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

Three moth species were collected in the light traps, all endemic species in the genus *Agrotis*. These moths were common in light traps. Also common were caterpillars of the family Noctuidae, captured in pitfall traps. Live caterpillars, when released from the traps, were observed burrowing into the cinder.

One specimen of the Haleakalā flightless moth was collected in a pitfall trap. These moths are difficult to capture in strong winds.

Other Observations

Several small red-colored centipedes were collected in pitfall traps.

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.



Caterpillars were common in pitfall traps. This one is burrowing into cinder after being released.

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

No endemic fruit flies (family Tephritidae) were found, but one specimen of the non-indigenous fruit fly was observed on *pukiawe*.

True Bugs - Orders Heteroptera and Homoptera

Adults and nymphs of two species of Hawaiian endemic seed bug (Heteroptera: Lygaeidae) were abundant on *Dubautia* and *pukiawe*. A smaller, dark colored seed bug, *Nysius lichenicola*, was collected in leaf litter under *pukiawe*.

Nymph plant bugs from the genus *Orthotylus*, were abundant on *Dubautia*. Another mirid, *Trigonotylus hawaiiensis* (Kirkaldy), was collected from grasses.

Two leafhoppers were detected, including an abundant endemic species, and a less common species of unknown status.

Bees and Wasps - Order Hymenoptera

Only one species of small wasp was observed, from the family Braconidae.



A single specimen of Black Witch was found in a light trap.

Moths - Order Lepidoptera

Six species of Lepidoptera were collected, four large moths, including three endemic species in the genus *Agrotis*, and the non-indigenous Black Witch, *Ascalapha odorata*. Caterpillars of the genus *Agrotis* were abundant in pitfall traps. Caterpillars of the Haleakalā flightless moth were infrequently captured in pitfall traps.

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. The species of indigenous arthropods detected have been observed at the site during other surveys.

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

HALE SAMPLING SITE

Sampling in HALE occurred near the Entrance Station (HALE ES) at 6,250 feet elevation. Thirty-five species of arthropods were collected and observed there. The species included ten endemic Hawaiian arthropods, fifteen non-indigenous arthropods, and ten species of unknown status.

Spiders - Order Araneae

Three species of spiders were observed during sampling. A Black Widow (*Lactrodectus mactans* (Fabricius)) was found under a rock. A crab spider (family Thomisidae), and an unknown spider were observed on foliage. All species were infrequent, only one specimen of each was found.

Beetles - Order Coleoptera

Two species of beetle were observed, including an endemic ground beetle (*Mecyclothorax* sp.), and a non-indigenous ground beetle (*Trechus obtusus* Erichson). Both were infrequent in pitfall traps.

Flies - Order Diptera

Nine species of flies were seen at the HALE ES, including a species of crane fly (family Tipulidae), a likely indigenous

species that comes to the light traps. Also observed were non-indigenous species of the families Sarcophagidae, Calliphoridae, Muscidae, Syrphidae, as well as unknown species from the families Chironomidae and Phoridae. All have been observed during previous sampling sessions.

True Bugs - Orders Heteroptera and Homoptera

Three species of true bugs (Heteroptera) were found, all from the family Miridae. All have been previously reported from the HALE ES. An *Orthotylus* species was abundant on mamane trees, and a *Sarona* species were common on *pilo* (*Coprosma montana*). A second *Orthotylus* species was also observed on *pilo*.

Two species of Homoptera were observed, including the indigenous genera *Nesosydne* (family Delphacidae), and a non-indigenous species of leafhopper (family Cicadellidae).

Bees and Wasps - Order Hymenoptera

The five species of Hymenoptera found near the HALE Entrance Station. Honey bees were uncommon on manane, two species of ants, both previously observed

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

at the HALE ES, and two species from the family Ichneumonidae. As was the case at HO this season, no yellow-faced bees were observed. All Hymenoptera observed have been previously reported from Haleakalā.

Moths - Order Lepidoptera

Six species of Lepidoptera were observed or captured during this study at the HALE ES. The list includes four endemic species and one non-indigenous biocontrol species.

Sowbugs - Class Isopoda

One species of sowbug was found under rocks and plant debris at the HALE ES. The species was abundant as juveniles.

Other Observations

Centipedes and millipedes were abundant under rocks and in pitfall traps. A Psocoptera was present on foliage. A brown lace-wing was also observed on manane as a single specimen.

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. The species of indigenous arthropods detected have been observed at the site during other surveys.

DISCUSSION

The arthropods that were found during this sampling are characteristic of the fauna at both sites. No new invasive arthropods were detected at either site.

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.

Abundance of arthropods at the DKIST site was lower than that seen in sampling sessions before construction was started. This is due to the removal of native plants during excavation and site

preparation for the new telescope. Populations of arthropods on the remaining foliage were similar to that observed during previous preconstruction monitoring sessions.

The conservation fencing to exclude goats appears to be returning benefits. Young vegetation is beginning to appear throughout the DKIST and HO sites. At least some recovery in arthropod abundance may be expected at the DKIST site once ground disturbing activities are completed and vegetation begins to reestablish.

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

APPENDIX A HO ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the Summer 2014 sampling at the HO site.

Class	Order	Family	Genus	Species	Authority	Status
Arachnida	Acari	mite				unknown
Arachnida	Araneae	Lycosidae	Lycosa	hawaiiensis	simon	endemic
CHILOPODA	Lithobiomorpha	Henicopidae	Lamyctes	emarginatus		non-indigenous
Collembola	Entomobriidae					endemic
Insecta	Coleoptera	Cerambycidae	Plagithmysus	dubautianus	Gressit and Davis	endemic
Insecta	Coleoptera	Coccinellidae	Coccinella	septempunctata	Linnaeus	non-indigenous
Insecta	Coleoptera	Coccinellidae	Hippodemia	convergens	Gurein-Meneville	non-indigenous
Insecta	Coleoptera	Coccinellidae	Olla	v-nigrum	(Mulsant)	non-indigenous
Insecta	Diptera	Calliphoridae	Calliphora	vomitaria	(Linnaeus)	non-indigenous
Insecta	Diptera	Calliphoridae	Lucilia	sericata	(Meigen)	non-indigenous
Insecta	Diptera	Calliphoridae	SP1			
Insecta	Diptera	Dolichopodidae	Campsicnemus	viridulus	Hardy and Kohn	endemic
Insecta	Diptera	Muscidae	Haematobia	irritans	(Linnaeus)	non-indigenous
Insecta	Diptera	Sarcophagidae				
Insecta	Diptera	Syrphidae	Allograpta	exotica	(Weidemann)	non-indigenous
Insecta	Diptera	Tachinidae	SP1			non-indigenous
Insecta	Diptera	Tephritidae	Trupanea	sp.		endemic
Insecta	Diptera	Tephritidae				
Insecta	Heteroptera	Lygaeidae	Nysius	coenosulus	Stål	endemic
Insecta	Heteroptera	Lygaeidae	Nysius	communis	Usinger	endemic
Insecta	Heteroptera	Lygaeidae	Nysius	lichenicola	Kirkaldy	endemic
Insecta	Heteroptera	Miridae	Orthotylus	sp.1		endemic
Insecta	Heteroptera	Miridae	Trigonotylus	hawaiiensis	(Kirkaldy)	endemic
Insecta	Homoptera	Cicadellidae	SP1			unknown
Insecta	Homoptera	Delphacidae	Nesosydne	sp. 1		endemic
Insecta	Hymenoptera	Eurytomidae				non-indigenous
Insecta	Lepidoptera	Noctuidae	Agrotis	biliopa	Meyrick	endemic
Insecta	Lepidoptera	Noctuidae	Agrotis	epicremna	Meyrick	endemic

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

Class	Order	Family	Genus	Species	Authority	Status
Insecta	Lepidoptera	Noctuidae	Agrotis	mesotoxa	Meyrick	endemic
Insecta	Lepidoptera	Noctuidae	larvae			
Insecta	Lepidoptera	Oecophoridae	Thryocopa	apatela	(Walsingham)	endemic

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

APPENDIX B DKIST ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the Summer 2014 sampling at the DKIST site.

Class	Order	Family	Genus	Species	Authority	Status
Arachnida	Acari					unknown
Arachnida	Araneae	Lycosidae	Lycosa	hawaiiensis	simon	endemic
CHILOPODA	Lithobiomorpha	Henicopidae	Lamyctes	emarginatus		non-indigenous
Collembola	Entomobriidae					endemic
DIPLOPODA	Julida	Allajulus	latistriatus		(Curtis)	non-indigenous
Insecta	Coleoptera	Anobiidae	Xyletobius			endemic
Insecta	Coleoptera	Coccinellidae	Coccinella	septempunctata	Linnaeus	non-indigenous
Insecta	Coleoptera	Coccinellidae	Hippodemia	convergens	Gurein-Meneville	non-indigenous
Insecta	Coleoptera	Coccinellidae	Olla	v-nigrum	(Mulsant)	non-indigenous
Insecta	Diptera	Calliphoridae	Calliphora	vomitaria	(Linnaeus)	non-indigenous
Insecta	Diptera	Calliphoridae	Lucilia	sericata	(Meigen)	non-indigenous
Insecta	Diptera	Dolichopodidae	Campsicnemus	viridulus	Hardy and Kohn	endemic
Insecta	Diptera	Muscidae	Haematobia	irritans	(Linnaeus)	non-indigenous
Insecta	Diptera	Syrphidae	Allograpta	exotica	(Weidemann)	non-indigenous
Insecta	Diptera	Tachinidae	SP1			non-indigenous
Insecta	Diptera	Tephritidae				unknown
Insecta	Heteroptera	Lygaeidae	Nysius	coenosulus	Stål	endemic
Insecta	Heteroptera	Lygaeidae	Nysius	communis	Usinger	endemic
Insecta	Heteroptera	Lygaeidae	Nysius	lichenicola	Kirkaldy	endemic
Insecta	Heteroptera	Miridae	Orthotylus	sp.1		endemic
Insecta	Heteroptera	Miridae	Trigonotylus	hawaiiensis	(Kirkaldy)	endemic
Insecta	Homoptera	Cicadellidae	SP1			unknown
Insecta	Homoptera	Delphacidae	Nesosydne	sp. 1		endemic
Insecta	Homoptera	Psyllidae	SP1			unknown
Insecta	Hymenoptera	Braconidae				unknown
Insecta	Lepidoptera	Noctuidae	Agrotis	biliopa	Meyrick	endemic
Insecta	Lepidoptera	Noctuidae	Agrotis	epicremna	Meyrick	endemic
Insecta	Lepidoptera	Noctuidae	Agrotis	mesotoxa	Meyrick	endemic

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

Class	Order	Family	Genus	Species	Authority	Status
Insecta	Lepidoptera	Noctuidae	Ascalapha	odorata		non-indigenous
Insecta	Lepidoptera	Noctuidae	larvae			unknown
Insecta	Lepidoptera	Oecophoridae	Thryocopa	apatela	(Walsingham)	endemic

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

APPENDIX B HALE ES ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the Summer 2014 sampling at the
HALE Entrance Station.

Class	Order	Family	Genus	Species	Authority	Status
Arachnida	Araneae	Theridiidae	Lactrodectus	mactans	(Fabricius)	non-indigenous
Arachnida	Araneae	Thomisidae				unknown
Arachnida	Araneae	Unknown 2				unknown
CHILOPODA	Lithobiomorpha	Henicopidae	Lamyctes	emarginatus		non-indigenous
Crustacea	Isopoda	Porcellionidae	Porcellio	scaber	Latreille	non-indigenous
DIPLOPODA	Julida	Allajulus	latistriatus		(Curtis)	non-indigenous
Insecta	Coleoptera	Carabidae	Mecyclothorax	spp.		endemic
Insecta	Coleoptera	Carabidae	Trechus	obtusus	Erichson	non-indigenous
Insecta	Diptera	Calliphoridae	Calliphora	vomitorea	(Linnaeus)	non-indigenous
Insecta	Diptera	Calliphoridae	Lucilia	sericata	(Meigen)	non-indigenous
Insecta	Diptera	Chironomidae				unknown
Insecta	Diptera	Muscidae	Haematobia	irritans	(Linnaeus)	non-indigenous
Insecta	Diptera	Phoridae				unknown
Insecta	Diptera	Sarcophagidae				non-indigenous
Insecta	Diptera	Sciaridae				unknown
Insecta	Diptera	Syrphidae	Allograpta	exotica	(Weidemann)	non-indigenous
Insecta	Diptera	Tipulidae				unknown
Insecta	Heteroptera	Miridae	Orthotylus	mamane		endemic
Insecta	Heteroptera	Miridae	Orthotylus	sp.1		endemic
Insecta	Heteroptera	Miridae	Sarona	sp.		endemic
Insecta	Homoptera	Cicadellidae	SP1			unknown
Insecta	Homoptera	Delphacidae	Nesosydne	sp.		endemic
Insecta	Hymenoptera	Apidae	Apis	mellifera	Linnaeus	non-indigenous
Insecta	Hymenoptera	Formicidae	Hypoconera	opaciceps	(Mayr)	non-indigenous
Insecta	Hymenoptera	Formicidae	Linepithema	humile	(Mayr)	non-indigenous

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

Class	Order	Family	Genus	Species	Authority	Status
Insecta	Hymenoptera	Ichneumonidae	Echthromorpha	agrestoria	(Fabricius)	endemic
Insecta	Hymenoptera	Ichneumonidae				unknown
Insecta	Lepidoptera	Cosmopterigidae	Hyposmocoma	sp.1		endemic
Insecta	Lepidoptera	Crambidae	Eudonia	sp.		endemic
Insecta	Lepidoptera	Crambidae	Udea	pyranthes	(Meyrick)	endemic
Insecta	Lepidoptera	Pterophoridae	Stenoptilodes	littoralis	(Meyrick)	non-indigenous
Insecta	Lepidoptera	Tortricidae	Cydia	plicata	(Walsingham)	endemic
Insecta	Lepidoptera	Unknown	larva			unknown
Insecta	Neuroptera	Hemerobiidae	Hemerobius	pacificus	Banks	non-indigenous
Insecta	Pscoptera					unknown