

**Programmatic Arthropod Monitoring at  
the Haleakalā High Altitude Observatories  
and Haleakalā National Park**

**Maui, Hawai'i**

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Prepared for

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# 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 Advanced Technology Solar Telescope (ATST) within the 18-acre University of Hawai'i Institute for Astronomy High Altitude Observatories (HO) site. The ATST represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The ATST 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 ATST Project will be contained within a 0.74 acre site footprint in the HO site. An Environmental Impact Statement was completed for the ATST project (NSF 2009), and the NSF issued a Record of Decision in December of 2009.

The Haleakalā National Park (HALE) Road Corridor will be used for transportation during construction and use of the ATST. 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 ATST 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. Two additional sampling sessions occurred in 2011.

This is a report of the sampling conducted in March 2012, the first of two sampling sessions that will be conducted in 2012. The goal is to monitor the arthropod fauna at the proposed ATST site and along the HALE Road Corridor, identify Hawaiian native arthropod species or habitats, if any, that may be impacted by construction or operation of the ATST, and detect and identify alien invasive arthropod species that could



### 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 Advanced Technology Solar Telescope (ATST) within the 18-acre University of Hawai'i Institute for Astronomy High Altitude Observatories (HO) site. The ATST represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community. The ATST 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 ATST Project will be contained within a 0.74 acre site footprint in the HO site. An Environmental Impact Statement was completed for the ATST project (NSF 2009), and the NSF issued a Record of Decision in December of 2009. The Haleakalā National Park (HALE) Road

Corridor will be used for transportation during construction and use of the ATST.

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 in the 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

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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 ATST sites, and identify Hawaiian native arthropod species or habitats, if any, that could be impacted by construction or operation of the ATST. 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 shrubland habitat zones, depending upon the elevation. These habitats contain several native and non-native species of plants, animals, and arthropods. The subalpine shrubland 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 proposed ATST 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 environmental changes.

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.





#### 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 ATST site and along the HALE Road Corridor?

##### **Justification:**

Programmatic Monitoring will yield a comprehensive description of the characteristic arthropod populations at the ATST site and along the HALE Road Corridor. The monitoring will provide reliable scientific information about their current status and trends in their populations, including all species of special interest.

##### **Monitoring goals:**

- 1) To describe the characteristic arthropod populations at the ATST site and along the HALE Road Corridor,
- 2) To provide historical records of change in native arthropod species population attributes, and characteristics.



## V. METHODS

### Site Description

The Haleakalā High Altitude Observatories (HO) site is located on 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 telescope facilities.

The ATST 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.

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.

### 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.



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than 100 feet, and traps were always located more than 100 feet from the nearest petrel burrow. Light traps were run every night for three nights at the ATST site and for three nights at the HALE site.

#### **Other light sampling at night**

Night collecting can be aided by a UV light source. An ultraviolet blacklight was placed on top of a white sheet and arthropods that were attracted to the light were collected as they are observed.

Small handheld ultraviolet blacklights were also 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 all vegetation intact.

#### **Nets**

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

#### **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 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), and Gagné (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.



## VI. RESULTS and DISCUSSION

### HO ATST SITE

Sixteen species of arthropods were collected at the HO ATST site during the March 2012 sampling session. The species included nine endemic Hawaiian arthropods, four non-indigenous arthropods, and three species of unknown status.

#### Moths - Order Lepidoptera

Two moths were collected in the light traps both of the native species from the *Agrotis epicremna* Meyrick from the family Noctuidiae. No specimens of the Haleakalā flightless moth (*Thyrocopa apatela*) were observed

#### True Bugs - Order Hemiptera

Two species of seed bugs (Heteroptera: Lygaeidae) were observed including One species was particularly abundant, *Nysius coenosulus* Stål. The other was a single specimen of *Nysius terrestris* Usinger. Several species that are normally observed at the site were not present. Insect populations can fluctuate seasonally, and abundance is often influenced by weather and other environmental factors.

Other Heteroptera present include two indigenous plant bugs (family Miridae), *Trigonotylus hawaiiensis* (Kirkaldy), collected from the base of grasses and a species of *Orthotylus*, found on *Dubautia*. Both species were not abundant on the site, likely due to seasonal fluctuations in populations.

One species of the endemic genus of plant hoppers (*Nesosydne*) was found. These bugs can be abundant at times but were also in low abundance during this trip.

#### Bees and Wasps - Order Hymenoptera

One species of endemic yellow-faced bee (Family Colletidae) was collected on *pūkiawe*. Wasps comprise two species, one small parasitoid and one Ichneumonid.

#### Flies - Order Diptera

One species of fruit flies (family Tephritidae) were found, a non-indigenous species uncommon at the site on *pūkiawe*. The nonindigenous blowfly *Calliphora vomitoria* (Linnaeus) was also collected at the site.



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**Beetles - Order Coleoptera**

One species of purposely introduced lady bird beetle was collected. These beetles often congregate at high elevations. One species of nonindigenous Carabidae beetle, *Trechus obtusus* Erichson, was captured in pitfall traps.

**Collembola - Order Springtails**

One species of Collembola was observed under pukiaawe plants and in pitfall traps.

**Araneae - Spiders**

Juvenile and adult Lycosid spiders, *Lycosa hawaiiensis* Simon, occurred in pitfall traps, but only juveniles were seen actively foraging among rocks.

A complete list of arthropods observed during this sampling session at the ATST 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.

## HALE SAMPLING SITE

Thirty-one species of arthropods were collected and observed near the HALE Entrance Station. The species included ten endemic Hawaiian arthropods, thirteen non-indigenous arthropods, and eight species of unknown status.

### **Moths - Order Lepidoptera**

Five species of Lepidoptera were observed or captured during this study. Two species of endemic Noctuid moths were captured in the light traps, *Agrotis baliopa* Meyrick and *A. xiphias* Meyrick. A nonindigenous Noctuid was also captured in the light traps, *Pseudaletia unipunctata* (Haworth) which was the most abundant moth observed during this sampling. An indigenous microlepidoptera, *Hyposmocoma* sp., and a species, *Cydia plicata*, were observed flying during the day.

### **True Bugs - Order Hemiptera**

Three species of true bugs (Heteroptera) were found, all from the family Miridae and all previously reported from the higher elevations of Haleakalā. An *Orthotylus* species was abundant on mamane trees, and two *Sarona* species were common on Pilo (*Coprosma Montana*).

Two species of Homoptera were also observed, including the indigenous species *Nesosydne* (family Delphacidae), and *Nesophrosyne* (family Cicadellidae).

### **Bees and Wasps - Order Hymenoptera**

The five species of Hymenoptera found near the HALE Entrance Station included honey bees uncommon on manane and pukiawe, an endemic yellow-faced bee, *Hylaeus nivicola* Meade-Waldo, and two parasitoids, and the invasive ant, *Hypoponera opaciceps* (Mayr). The latter are serious pests and efforts are being made to eradicate them in HALE.

### **Flies - Order Diptera**

Three species of flies were seen, including a species of crane fly (family Tipulidae), that is likely an indigenous species that comes to the light traps.

### **Beetles - Order Coleoptera**

One species of beetle, the nonindigenous *Trechus obtusus* Erichson (family Carabidae) was captured in pitfall traps.

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**Collembola - Order Springtails**

Two species of Collembola were captured in pitfall traps. Both were indigenous families, Entomobryidae and Hypogastruridae.

**Araneae - Spiders**

Two species of spiders were collected, both of unknown status and both as juveniles.

Other arthropods include nonindigenous pillbugs, earwigs, and centipedes, and a millipede and a booklice of unknown status. Also observed were garlic snails (*Oxychilus alliarius* (J.S. Miller)), flatworms (*Platydemus manokwari*).

**DISCUSSION**

The arthropods that were found during this sampling are characteristic of the fauna at both sites. Several species that have been observed during other samplings that were not present during this trip are likely absent because of the timing of the sampling, weather conditions, or their rarity. No new

invasive arthropods were detected at either site.

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







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## APPENDIX A HO ATST ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the March 2012 sampling at the HO ATST site.

Class	Order	Family	Genus	Species	Subspecies	Authority	Status
Arachnida	Araneae	Lycosidae	Lycosa	hawaiiensis		Simon	endemic
CHILOPODA	Lithobiomorpha	Henicopidae	Lamyctes	emarginatus			non-indigenous
Collembola	Entomobriidae						endemic
Insecta	Coleoptera	Carabidae	Trechus	obtusus		Erichson	non-indigenous
Insecta	Coleoptera	Coccinellidae	Coccinella	septempunctata		Linnaeus	non-indigenous
Insecta	Diptera	Calliphoridae	Calliphora	vomitaria		(Linnaeus)	non-indigenous
Insecta	Diptera	Tephritidae	Neotephritis				
Insecta	Heteroptera	Lygaeidae	Nysius	coenosulus		Stål	endemic
Insecta	Heteroptera	Lygaeidae	Nysius	terrestris		Usinger	endemic
Insecta	Heteroptera	Miridae	Orthotylus	sp.1			endemic
Insecta	Heteroptera	Miridae	Trigonotylus	hawaiiensis		(Kirkaldy)	endemic
Insecta	Homoptera	Delphacidae	Nesosydne	osborni			endemic
Insecta	Hymenoptera	Colletidae	Hylaeus	nivicola		Meade-Waldo	endemic
Insecta	Hymenoptera	Ichneumonidae					
Insecta	Hymenoptera	Unknown 12					
Insecta	Lepidoptera	Noctuidae	Agrotis	billiopa		Meyrick	endemic

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## APPENDIX B HALE ARTHROPOD SPECIES LIST

A list of Arthropod species detected during the March 2012 sampling at the  
HALE Entrance Station.

Class	Order	Family	Genus	Species	Subspecies	Authority	Status
Arachnida	Araneae	Immature		sp. 1			
Arachnida	Araneae	Immature		sp. 2			
Collembola	Entomobryidae						endemic
Collembola	Hypogastruridae						endemic
Crustacea	Isopoda	Porcellionidae	Porcellio	scaber		Latreille	non-indigenous
Diplopoda	Julida	Allajulus	latistriatus			(Curtis)	non-indigenous
Gastropoda	Stylommatophora	Zonitidae	Oxychilus	allarius		(J.S. Miller)	non-indigenous
Insecta	Coleoptera	Carabidae	Trechus	obtusus		Erichson	non-indigenous
Insecta	Coleoptera	Curculionidae					non-indigenous
Insecta	Dermaptera	Forficulidae	Forficula	auricularia		Linnaeus	non-indigenous
Insecta	Diptera	Calliphoridae	Phormia	regina		(Meigen)	non-indigenous
Insecta	Diptera	Culicidae					non-indigenous
Insecta	Diptera	Tipulidae	SP1				
Insecta	Heteroptera	Miridae	Orthotylus	sp.2			endemic
Insecta	Heteroptera	Miridae	Sarona	sp. 1			endemic
Insecta	Heteroptera	Miridae	Sarona	sp. 2			
Insecta	Homoptera	Cicadellidae	Nesophrosyne	sp. 1			endemic
Insecta	Homoptera	Delphacidae	Nesosydne	sp. 1			endemic
Insecta	Hymenoptera	Apidae	Apis	mellifera		Linnaeus	non-indigenous
Insecta	Hymenoptera	Colletidae	Hylaeus	nivicola		Meade-Waldo	endemic
Insecta	Hymenoptera	Formicidae	Hypoconera	opaceps		(Mayr)	non-indigenous
Insecta	Hymenoptera	Ichneumonidae					
Insecta	Hymenoptera	Unknown 13					
Insecta	Lepidoptera	Cosmopterigidae	Hyposmocoma	sp.1			endemic
Insecta	Lepidoptera	Noctuidae	Agrotis	epicremna		Meyrick	endemic
Insecta	Lepidoptera	Noctuidae	Agrotis	xiphias		Meyrick	endemic
Insecta	Lepidoptera	Noctuidae	Pseudaletia	unipunctata		(Haworth)	non-indigenous
Insecta	Lepidoptera	Pterophoridae	Stenoptilodes	tapobanes	brachymorpha	(Meyrick)	non-indigenous
Insecta	Lepidoptera	Tortricidae	Cydia				
Insecta	Psocoptera						
Turbellaria	Tricladida	Rhynchodemidae	Platydemus	manokwari			non-indigenous