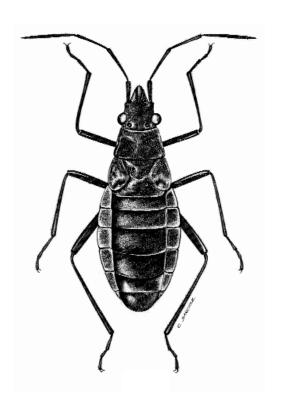
WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 4th QUARTER 2005





Pacific Analytics, L.L.C.

WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 4th QUARTER 2005

Prepared for

The Outrigger Telescopes Project WM Keck Observatory Kamuela, Hawai'i



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Cover: Wēkiu Bug drawn by Mr. C. Sanchez of the University of the Philippines College of Science and Humanities.

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WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 4th QUARTER 2005

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Wēkiu Bug Baseline Monitoring EXECUTIVE SUMMARY

II. EXECUTIVE SUMMARY

The Mauna Kea Science Reserve (MKSR) is located on the summit of Mauna Kea, the tallest mountain in Hawai'i. Within the reserve are the world's two largest optical telescopes, constituting the W.M. Observatory (WMKO). The slopes of Pu'u Hau'oki directly adjacent to and below the WMKO are part of a unique natural environment that supports the Wēkiu bug, a rare insect. Wēkiu bug habitat generally occurs on the upper elevations of Mauna Kea. Populations of Wēkiu bugs also occur on other cinder cones above about 11,700' (3,570 m) elevation.

The National Aeronautics and Space Administration (NASA), together with the California Institute of Technology (CalTech)/Jet Propulsion Laboratory (JPL), the California Association for Research in Astronomy (CARA) and the University of Hawai'i (UH), have proposed to protect and enhance Wēkiu bug habitat on Pu'u Hau'oki to mitigate potential disturbance by onsite construction and installation of the Outrigger Telescopes Project. To that end these participants have prepared the Wēkiu Bug Mitigation Plan and Wēkiu Bug Monitoring Plan. They are

also the participants in this Wēkiu Bug Baseline Monitoring Plan.

Sampling of Wēkiu bug habitat was approved to establish baseline population estimates of the Wekiu bug in the area surrounding the site of the proposed Outrigger Telescopes Project and at a control site on Pu'u Wēkiu. The intended purpose of this activity is to gather reliable scientific information about population trends in both areas that can be used to determine the effectiveness of habitat protection and restoration, and the impacts, if any, due to construction of the Outrigger Telescopes Project.

Sampling of Wēkiu bugs is being conducted to answer two main Questions of Interest. They are:

- 1) How, where and when are the Wēkiu bug populations changing? Locations of interest include current habitat on Pu'u Hau'oki crater and undisturbed Wēkiu bug habitat at Pu'u Wēkiu (for comparison).
- 2) Are weather phenomena, human activities, and/or other factors associated with Wēkiu bug and/or other resident arthropod population change?

Wēkiu Bug Baseline Monitoring EXECUTIVE SUMMARY

Nondestructive sampling is one of the best approaches to monitoring rare and sensitive invertebrate species. Special live-traps were developed and tested during the 1997-98 MKSR arthropod assessment and are being deployed during Baseline Monitoring. Twenty live-traps stations were installed at the summit of Mauna Kea at designated locations, ten on Pu'u Hau'oki and ten on Pu'u Wēkiu.

The 4th Quarter 2005 three-week sampling session was conducted from October 2, 2005 through October 22, 2005. During this sampling session a total of 48 Wēkiu bugs appeared in or near the live-traps. Forty Wēkiu bugs were found on Pu'u Hau'oki and eight were found on Pu'u Wēkiu. Sampling period trap capture rates ranged from 0.0 to 1.5 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Pu'u Hau'oki during the 4th Quarter 2005 monitoring session was 0.62 Wēkiu bugs per trap per 3 days of sampling. This rate is about one sixth of the highest average capture rate measured on Pu'u Hau'oki during a 4th Quarter baseline monitoring session (4.0 WB

2002), and about three times higher than the low (0.21 WB 2004).

The average trap capture rate on Pu'u Wēkiu during the 4th Quarter 2005 monitoring session was 0.12 Wēkiu bugs per trap per 3 days of sampling. This rate is about half of the highest average capture rate measured on Pu'u Wēkiu during a 4th Quarter baseline monitoring session (0.2 WB 2002), and twice the rate measured during the 4th Quarter 2004.

The 2005 yearly average trap capture rate on both cinder cones was the second highest recorded since 2002. The yearly average rates measured in 2003 were the highest for both cinder cones.

Fifty-four percent (26 of 48) of the Wēkiu bugs captured in the 4th Quarter 2005 sampling session were immature stages. The ratio was about the same on both Pu'u Hau'oki and on Pu'u Wēkiu.

Trap mortality for this quarter was about 2% (1 of 48). The improvements to the special live-traps appear to have reduced trap-caused mortality.

Wēkiu Bug Baseline Monitoring INTRODUCTION

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III. INTRODUCTION

The Mauna Kea Science Reserve is located on the summit of Mauna Kea, the tallest mountain in Hawai'i. Within the reserve are the world's two largest optical telescopes, constituting the W.M. Keck Observatory (WMKO). The slopes of Pu'u Hau'oki directly adjacent to and below the WMKO are part of a unique natural environment that supports the Wēkiu bug, a rare insect. Wēkiu bug habitat generally occurs on the upper elevations of Mauna Kea. Populations of Wēkiu bugs also occur on other cinder cones above 11,700' (3,570 m) elevation.

Current plans call for adding four to six Outrigger Telescopes on the WMKO site. The Outrigger Telescopes would be placed strategically around the existing Keck Telescopes.

The National Aeronautics and Space Administration (NASA), together with the California Institute of Technology (CalTech)/Jet Propulsion Laboratory (JPL), the California Association for Research in Astronomy (CARA) and the University of Hawai'i (UH), have proposed to protect and enhance Wēkiu bug habitat on Pu'u Hau'oki to mitigate potential disturbance by on-

site construction and installation of the Outrigger Telescopes Project. To that end these participants have prepared the Wēkiu Bug Mitigation Plan and Wēkiu Bug Monitoring Plan. They are also the participants in this Wēkiu Bug Baseline Monitoring Plan.

Sampling of Wekiu bug habitat was approved establish baseline to population estimates of the Wekiu bug in the area surrounding the site of the proposed Outrigger Telescopes Project and at a control site on Pu'u Wēkiu. The populations of Wekiu bugs were last measured at these sites in 1998 during an arthropod assessment which became part of the Environmental Impact Statement prepared for the Mauna Kea Science Reserve Master Plan approved in 2000 by the UH Board of Regents. This new activity will monitoring provide current information.

The intended purpose of the current activity is to gather reliable scientific information about population trends in both areas that can be used to determine the effectiveness of habitat protection and restoration, and the

Wēkiu Bug Baseline Monitoring INTRODUCTION

impacts, if any, due to construction of the Outrigger Telescopes Project.

The Hawai'i Department of Land and Natural Resources (DLNR) approved a recommendation for doubling the number of traps for Wēkiu bug monitoring. Five new monitoring stations were established on Pu'u Hau'oki and five on Pu'u Wēkiu during the 3rd Quarter 2004 monitoring session. All of the traps deployed for Wēkiu Bug Baseline Monitoring continue to be of the improved live-

trap design described in previous quarterly reports.

This is the sixteenth Quarterly Report of Baseline Monitoring. The results of the sampling effort conducted October 2, 2005 through October 22, 2005 are reported. Comparisons to previously collected data are presented, along with new analysis and interpretations of correlations of changes in Wēkiu bug populations with weather related phenomena.



A view of the Hale Pohaku observatory support facilities and Visitor Center.

Wēkiu Bug Baseline Monitoring QUESTIONS OF INTEREST

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 in the Baseline Monitoring Plan and are the focus of this report.

Question 1

How, where and when are the Wēkiu bug populations changing? Locations of interest include current habitat on Pu'u Hau'oki crater and undisturbed Wēkiu bug habitat at Pu'u Wēkiu (for comparison).

Justification:

Baseline monitoring of Wēkiu bugs will yield reliable scientific information about the current status of Wēkiu bugs, and trends in their population. The information will be useful to compare to status and trends during construction of the proposed Outrigger Telescopes.

Monitoring goals:

- 1) To provide historical records of change in Wēkiu bug population attributes, and characteristics,
- 2) To detect trends, periodicities, cycles, and/or other patterns in those changes, and
- 3) To associate auxiliary phenomena, attributes, and characteristics with trends and patterns of change in Wēkiu bug population attributes, and characteristics.

Wēkiu Bug Baseline Monitoring QUESTIONS OF INTEREST

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Question 2

Are weather phenomena, human activities, and/or other factors associated with Wēkiu bug and/or other resident arthropod population change?

Justification:

Snow, rain, day/night temperatures, and other weather phenomena may be associated with Wēkiu Bug population change. Monitoring these indirect factors will aid in understanding trends in Wēkiu Bug population change.

Monitoring goals:

To associate environmental phenomena and attributes, and characteristics of human activities with trends and patterns of change in Wēkiu Bug populations.



An early instar nymph Wēkiu bug. Actual size is about 3 mm.

Wēkiu Bug Baseline Monitoring METHODS

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V. METHODS

Live Traps

Nondestructive sampling is one of the best approaches to monitoring rare and sensitive invertebrate species. Data on relative abundance can be collected with specially designed live-traps that cause minimal disturbance to species and their habitats. Nondestructive live-traps for Wēkiu bugs were developed and tested during the 1997-98 MKSR arthropod assessment. These live-traps provide Wēkiu bugs with food, moisture, and protection from predators and changing weather conditions, and can sustain captured individuals for several days.

During the 4th Quarter 2005 sampling session twenty live-traps were open for the entire sampling session, 10 traps on Pu'u Hau'oki and 10 traps on Pu'u Wēkiu. Traps were set at the same monitoring stations installed during previous sampling sessions.

Protocol for Setting Live-Traps

The sampled habitat was accessed with a minimum of disturbance to the habitat and cinder slopes. Care was taken to avoid creation of new trails or evidence of foot traffic.

Monitoring stations were established in previous sampling sessions by carefully digging into the cinder, disturbing only the amount of cinder necessary to set up the trap (Step 1). A hardware cloth tube was inserted into the holes so that the top of the tube was slightly below the existing surface (Step 2). The hole around the tube was refilled with the cinder that was removed from the hole and a 4-inch apron of local ash and small-sized cinder was created around each trap (Step 3). The apron allows Wēkiu bugs to easily walk into the traps.

Traps were set at each available monitoring station by placing reservoir cups into the wire tubes and pouring about 15 ml of purified water into the reservoir (Step 4). About a teaspoon of shrimp paste was spread on the coffee filter wick in the trap cups and two to three pieces of re-hydrated shrimp were added to each cup (Step 5). Four to five pieces of native cinder, ½" to 1" in diameter were added and the trap cups were placed into the reservoir cups such that the coffee-filter wicks made contact with the water reservoirs (Step 6).

Chum, consisting of pre-moistened shrimp, was distributed around the

Wēkiu Bug Baseline Monitoring METHODS

traps and a teaspoon of shrimp paste was spread on the bottom of the cap rocks (Step 7). Irrigation flags to mark the locations were wrapped around cap rocks, ten to fifteen inches in diameter. The cap rocks were then placed over each trap such that the entire trap was shaded from sunlight (Step 8).

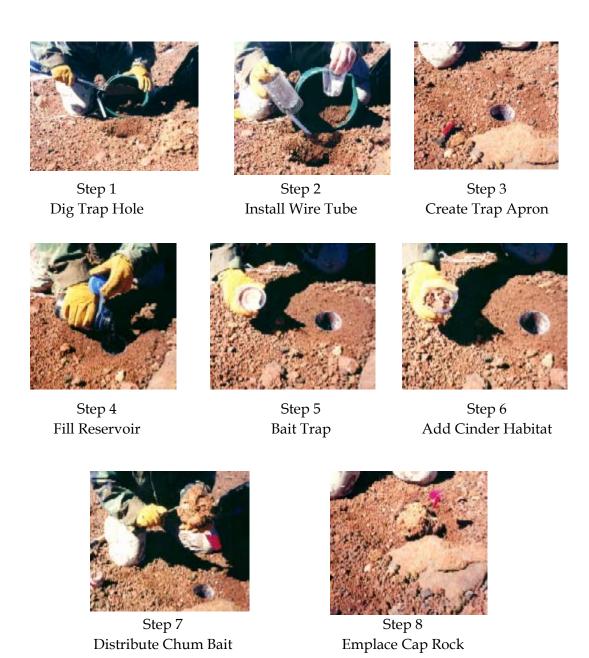
Traps were checked for Wēkiu bugs every three days during the sampling session, or as weather permitted. During each live-trap check, an area about 20 cm in diameter around the live-trap was checked for the presence of Wēkiu bugs. The cap rock was also inspected for the presence of Wēkiu bugs. The trap cups were then removed and carefully inspected for Wēkiu bugs. Live Wēkiu bugs were counted and released to cinder habitat one to two meters away from the live-trap. Dead arthropods were collected in vials filled with alcohol.

Live-traps were reset by topping off the water reservoir, and by placing new bait and chum in and around the live-traps. When the 3-week sampling session was complete, both cups were removed, and cap rocks placed over the wire tubes. Small identification tags containing contact information were attached to the flag wires. The same monitoring stations will be used for future sampling.

Traps were opened for the 4th Quarter 2005 baseline monitoring session on October 2, 2005. The traps were checked every three days beginning October 5, 2005 and were closed on October 22, 2005. Summit weather conditions did not impede sampling during this quarter of monitoring. Scheduling conflicts required that sampling for the last three sampling dates be moved up by one day, making the October 16 sampling a 2-day sampling period.

Wēkiu Bug Baseline Monitoring METHODS

Setting a Wēkiu Bug Live-Trap



Wēkiu Bug Baseline Monitoring METHODS

Weather Data

In order to improve the accuracy of temperature measurements and more closely correlate them with trap capture rates, data loggers were placed on each of the sampled cinder cones, Pu'u Hau'oki and Pu'u Wēkiu at the request of the Office of Mauna Kea Management (OMKM). Special permission for these data loggers was obtained from the Hawai'i Department Land and Natural Resources (DLNR). The data loggers were placed near the middle of the sampled slopes at the top of the ash layer and covered with native cinder to the original depth (about 4-6 inches). The data loggers measure and record temperature and humidity every 15 minutes. Data was downloaded every three days using a data shuttle. Data loggers used are the HOBO[©] H8 Pro Series model number H08-030-08 from Onset (www.onsetcomp.com). The

HOBO[©] Shuttle, model number H09-003-08 was used to download temperature data from the loggers.

Weather data have been collected using the data loggers since the 3rd Quarter 2004 monitoring session. This information represents measurements of substrate conditions. Before the 2nd Quarter 2004, weather information was obtained from the UKIRT Observatory Weather Station and represented general conditions of the summit area.

Archive photographs were taken from fixed points on Pu'u Hau'oki and on Pu'u Wēkiu. Photographs were taken at the beginning of each sampling period to record snow coverage and other changes in Wēkiu bug habitats through time.



HOBO© Temperature Data Logger.

Wēkiu Bug Baseline Monitoring RESULTS

VI. RESULTS

SAMPLING

During the 4th Quarter 2005 baseline monitoring session there were a total of twenty sampling nights, making six 3-day sampling periods and one 2-day sampling period.

A total of forty-eight Wēkiu bugs were captured, forty were captured on Pu'u Hau'oki and eight on Pu'u Wēkiu. The trap capture rate (number of Wēkiu bugs per trap per 3-days) ranged from 0.0 to 1.5 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 0.62 (±0.21) Wēkiu bugs for Pu'u Hau'oki, and 0.12 (±0.04) Wēkiu bugs for Pu'u Wēkiu (Table 1). For perspective, average trap capture rates from previous baseline monitoring sessions and the 1982 and 1997/98 Arthropod Assessments are provided (Table 2 and Table 3). Average trap capture rates reported for the 1982 and 1997/98 arthropod assessments are those measured in comparable locations on Pu'u Hau'oki crater and Pu'u Wēkiu as those measured for Wēkiu Bug Baseline Monitoring. The 1982 measurements were recorded during July and August.

Figure 1 graphs the log₁₀ average trap capture rates for all Baseline Monitoring on Pu'u Hau'oki (beginning 1st Quarter 2002). Figure 2 shows the quarterly variation in log₁₀ average trap capture rates for Baseline Monitoring on Pu'u Hau'oki.

Fifty-four percent (26 of 48) of the Wēkiu bugs captured in the 4th Quarter 2005 sampling session were immature stages.

Overall mortality was about 2% (1 of 48). This mortality rate is significantly less than the 40% experienced with the previous live-trap design used in the 1997/98 arthropod assessment. The improvements to the special live-traps appear to have reduced trap-caused mortality.

TABLE 1. 4th QUARTER 2005 SAMPLING PERIOD AVERAGE TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each sampling period during the 4th Quarter 2005 Baseline Monitoring.

Location	10/5/2005	10/8/2005	10/11/2005	10/14/2005	10/16/2005	10/19/2005	10/22/2005	AVERAGE ± SE
Pu'u Wēkiu	0.00	0.30	0.10	0.00	0.15	0.20	0.10	0.12 ± 0.04
Puʻu Hauʻoki	0.10	0.10	0.30	0.30	1.05	1.50	1.00	0.62 ± 0.21

TABLE 2. QUARTERLY BASELINE MONITORING AVERAGE TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each of the Quarterly Baseline Monitoring Sampling Sessions. Yearly average trap capture rates for Baseline Monitoring are in RED.

Location	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter	Year Avg.
Pu'u Wēkiu 2002*	0.03	0.03	0.3	0.2	0.1
Pu'u Wēkiu 2003	2.8	11.5	0.5	0.0	3.7
Pu'u Wēkiu 2004	0.00	2.0	0.03	0.06	0.5
Pu'u Wēkiu 2005	1.14	0.64	1.26	0.12	0.79
Puʻu Hauʻoki 2002	1.0	10.3	4.0	4.0	4.8
Puʻu Hauʻoki 2003	18.5	90.6	12.4	0.8	30.6
Puʻu Hauʻoki 2004	2.1	8.8	0.4	0.21	2.9
Puʻu Hauʻoki 2005	15.92	5.09	5.99	0.62	6.91

^{* -} different trap locations on Pu'u Wēkiu in 2002

TABLE 3. SAMPLING PERIOD AVERAGE TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each sampling period during the 1982 and 1997/98 Arthropod Assessments. Average trap capture rates for the 1997/98 Arthropod Assessment are in RED.

Location	Aug. 1997	Jan. 1998	Apr-98	Jul-98	1997/98 Avg.	Jul-82
Pu'u Wēkiu	0.15	0	0.07	0.15	0.11	225
Pu'u Hau'oki	0.2	0	0.2	1.1	0.38	105.6

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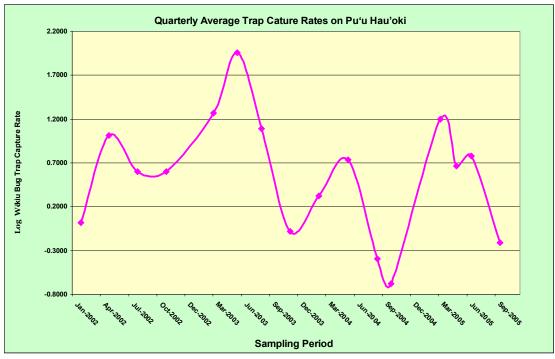


FIGURE 1. Graph of the log₁₀ Average Wēkiu Bug Trap Capture Rate per Sampling Period on Pu'u Hau'oki since Wēkiu Bug Baseline Monitoring began in February 2002.

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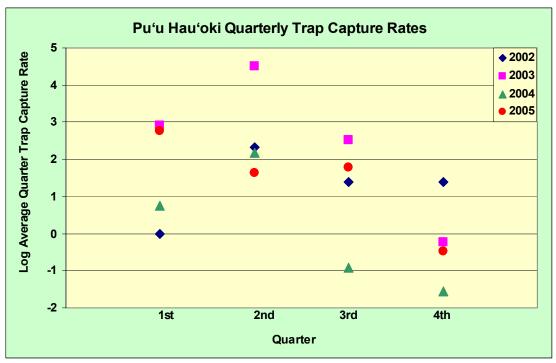


FIGURE 2. Pu'u Hau'oki Quarterly Average Trap Capture Rates. The log₁₀ average quarterly trap capture rate of Wēkiu bugs on Pu'u Hau'oki for four years of Wēkiu Bug Baseline Monitoring.

Wēkiu Bug Baseline Monitoring RESULTS

WEATHER INFORMATION

In past monitoring sessions, weather data was collected from nearby observatories that measure air temperature near those buildings. Because the two measurements appear to be quite different, new graphs will be presented that compare temperature and trap capture data for each quarterly sampling session (see Figure 3). Figure 4 will no longer be updated.

Figure 3 is a graph of the total number of Wekiu bugs captured in all traps versus average temperature for each sampling period in the 4th Quarter 2005 monitoring session. Temperature data is derived from HOBO© data loggers. In the previous monitoring sessions there was a strong indication that as

average temperature decreased, the number of Wēkiu bugs in the traps also decreased. And as temperatures increased the number of Wēkiu bugs in the traps increased. A similar trend was followed this quarter.

Graphs of previous monitoring sessions (before 2nd Quarter 2004) were based on temperature data collected by the UKIRT Observatory. Weather information was not available for the 2nd Quarter 2004 monitoring session due to damage at the UKIRT weather station. A Graph of the log average Wēkiu bug trap capture rate plotted with average temperature for quarterly sampling sessions up to the 2nd Quarter 2004 sampling session appears in Figure 4.

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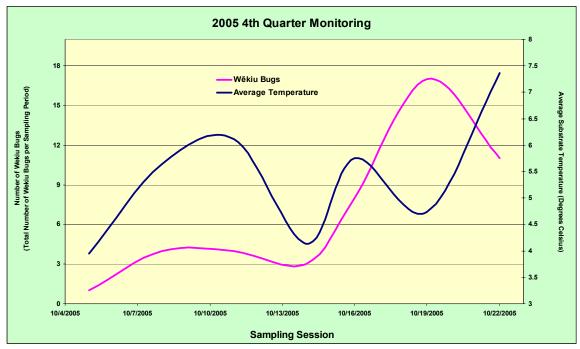


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured per Sampling Period at all sampling locations during the 4th Quarter 2005 sampling session.

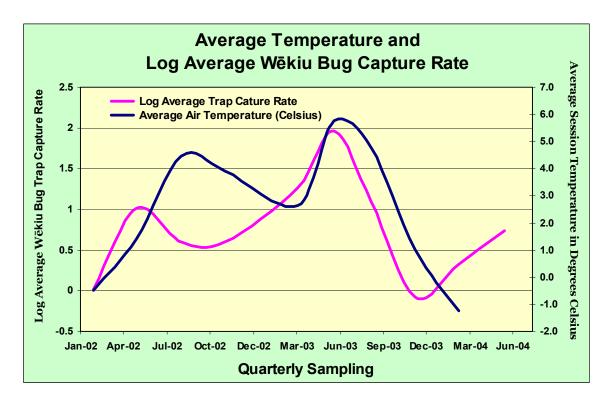


FIGURE 4. Plot of Baseline Monitoring Session Average Temperature (Celsius) and Natural Log Average Number of Wēkiu Bug Trap Capture Rate per Session on Pu'u Hau'oki.

Pu'u Hau'oki Inner Slope Photographic Archive

OCTOBER 2005 TRAPS 1 - 5



Pu'u Hau'oki inner slope October 02, 2005



Pu'u Hau'oki inner slope October 05, 2005



Pu'u Hau'oki inner slope October 08, 2005



Pu'u Hau'oki inner slope October 11, 2005

TRAPS 1 - 5



Pu'u Hau'oki inner slope October 14, 2005



Pu'u Hau'oki inner slope October 16, 2005



Pu'u Hau'oki inner slope October 19, 2005

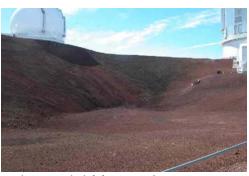


Pu'u Hau'oki inner slope October 22, 2005

OCTOBER 2005 TRAPS 6 - 10



Pu'u Hau'oki inner slope October 02, 2005



Pu'u Hau'oki inner slope October 05, 2005



Pu'u Hau'oki inner slope October 08, 2005



Pu'u Hau'oki inner slope October 11, 2005

TRAPS 6 - 10



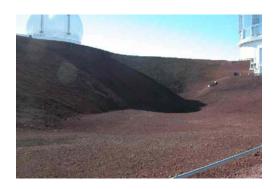
Pu'u Hau'oki inner slope October 14, 2005



Pu'u Hau'oki inner slope October 16, 2005



Pu'u Hau'oki inner slope October 19, 2005



Pu'u Hau'oki inner slope October 22, 2005

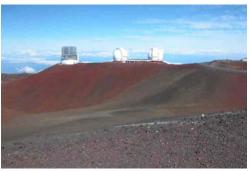
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Pu'u Hau'oki Outer Slope Photographic Archive

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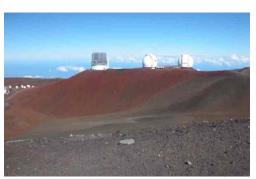
Pu'u Hau'oki outer slope October 02, 2005



Pu'u Hau'oki outer slope October 05, 2005



Pu'u Hau'oki outer slope October 08, 2005



Pu'u Hau'oki outer slope October 11, 2005



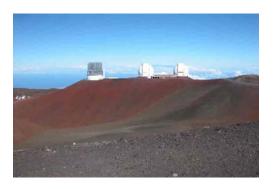
Pu'u Hau'oki outer slope October 14, 2005



Pu'u Hau'oki outer slope October 16, 2005



Pu'u Hau'oki outer slope October 19, 2005



Pu'u Hau'oki outer slope October 22, 2005

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Pu'u Wēkiu Photographic Archive

OCTOBER 2005 TRAPS 1 - 5



Pu'u Wēkiu inner slope October 02, 2005



Pu'u Wēkiu inner slope October 05, 2005



Pu'u Wēkiu inner slope October 08, 2005



Pu'u Wēkiu inner slope October 11, 2005

TRAPS 1 - 5



Pu'u Wēkiu inner slope October 14, 2005



Pu'u Wēkiu inner slope October 16, 2005



Pu'u Wēkiu inner slope October 19, 2005



Pu'u Wēkiu inner slope October 22, 2005

OCTOBER 2005 TRAPS 6 - 10



Pu'u Wēkiu inner slope October 02, 2005



Pu'u Wēkiu inner slope October 05, 2005



Pu'u Wēkiu inner slope October 08, 2005



Pu'u Wēkiu inner slope October 11, 2005

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TRAPS 6 - 10



Pu'u Wēkiu inner slope October 14, 2005



Pu'u Wēkiu inner slope October 16, 2005



Pu'u Wēkiu inner slope October 19, 2005



Pu'u Wēkiu inner slope October 22, 2005

Pu'u Wēkiu and Pu'u Hau Kea Photographic Archive

OCTOBER 2005



Pu'u Wēkiu and Pu'u Hau Kea October 02, 2005



Pu'u Wēkiu and Pu'u Hau Kea October 05, 2005



Pu'u Wēkiu and Pu'u Hau Kea October 08, 2005



Pu'u Wēkiu and Pu'u Hau Kea October 11, 2005



Pu'u Wēkiu and Pu'u Hau Kea October 14, 2005



Pu'u Wēkiu and Pu'u Hau Kea October 16, 2005



Pu'u Wēkiu and Pu'u Hau Kea October 19, 2005



Pu'u Wēkiu and Pu'u Hau Kea October 22, 2005

Wēkiu Bug Baseline Monitoring DISCUSSION

VII. DISCUSSION

Trapping Data

Permission to begin Baseline Wēkiu bug monitoring was received on January 21, 2002. On January 28, 2002 Pacific Analytics personnel installed 10 live-trap monitoring stations in designated areas, five on the inner slopes of Pu'u Hau'oki and five on the slopes of Pu'u Wēkiu. Sampling began in February 2002.

Over the four quarters of monitoring during 2002, 696 Wēkiu bugs were captured in live-traps, and Wēkiu bug trap capture rates averaged 4.82 bugs per trap per 3-day trapping period on Pu'u Hau'oki, and 0.13 bugs per trap per 3-day trapping period on Pu'u Wēkiu.

Over the four quarters of monitoring during 2003, 4,237 Wēkiu bugs were captured in live-traps. Wēkiu bug trap capture rates averaged 30.57 bugs per trap per 3-day trapping period on Pu'u Hau'oki, and 3.71 bugs per trap per 3-day trapping period on Pu'u Wēkiu.

Over the four quarters of monitoring during 2004, 518 Wēkiu bugs were captured in live-traps. Wēkiu bug trap capture rates averaged 2.9 bugs per trap per 3-day trapping period on Pu'u

Hau'oki, and 0.5 bugs per trap per 3-day trapping period on Pu'u Wēkiu.

During the 1st Quarter 2005 sampling session a total of 458 Wēkiu bugs appeared in the traps. The average trap capture rate on Pu'u Hau'oki was 15.92 WB. The average trap capture rate on Pu'u Wēkiu was 1.14 WB.

During the 2nd Quarter 2005 sampling session a total of 370 Wēkiu bugs appeared in the traps. The average trap capture rate on Pu'u Hau'oki was 5.09 WB. The average trap capture rate on Pu'u Wēkiu was 0.64 WB.

During the 3rd Quarter 2005 sampling session a total of 507 Wēkiu bugs appeared in the traps. The average trap capture rate on Pu'u Hau'oki was 5.99 WB. The average trap capture rate on Pu'u Wēkiu was 1.26 WB.

During the 4th Quarter 2005 sampling session Wēkiu bugs appeared in all ten traps on Pu'u Hau'oki and five of the ten traps on Pu'u Wēkiu. A total of 48 Wēkiu bugs appeared in or near the traps during the seven trapping sessions. All live bugs were released back into their habitat.

Wēkiu Bug Baseline Monitoring DISCUSSION

Average 4th Quarter 2005 trap capture rate on Pu'u Hau'oki was 0.62 (±0.21) bugs per trap per 3-day trapping period. Average 4th Quarter 2005 trap capture rate on Pu'u Wēkiu was 0.12 (±0.04) bugs per trap per 3-day trapping period.

The average trap capture rate of 0.62 on Pu'u Hau'oki during the 4th Quarter 2005 monitoring session is about one sixth of the highest average capture rate measured on Pu'u Hau'oki during a 4th Quarter baseline monitoring session (4.0 WB 2002) (Table 2), and about three times higher than the low (0.21 WB 2004)

The average trap capture rate on Pu'u Wēkiu during the 4th Quarter 2005 monitoring session was 0.12 Wēkiu bugs per trap per 3 days of sampling. This rate is about half of the highest average capture rate measured on Pu'u Wēkiu during a 4th Quarter baseline monitoring session (0.2 WB 2002), and twice the rate measured during the 4th Quarter 2004.

Fifty-four percent (26 of 48) of the Wēkiu bugs captured in the 4th Quarter 2005 sampling session were immature stages. The presence of immature stages is strong evidence that the population of Wēkiu bugs on Mauna Kea is breeding.

About 2% (1 of 48) of the Wēkiu bugs captured during the 4th Quarter 2005 sampling session died in live-traps. The improvements to the special live-traps appear to have reduced trapcaused mortality.

Other Observations

During the 4th Quarter 2005 monitoring session the WMKO site was free of loose trash and debris. Observatory vehicles parked near the WMKO were clean. Inspections of vehicles parked at the WMKO found no visible signs of alien arthropods.



Covered trash container used to remove trash from the W. M. Keck Observatory. Photo taken October 14, 2005.

Trash containers with locking lids are used to remove trash from the WMKO. Upon inspection the container and truck used for hauling were found to have been recently pressured washed, and were free of dirt and alien arthropods.

Wēkiu Bug Baseline Monitoring DISCUSSION

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There was evidence of people walking in Wēkiu bug habitat inside the crater of Pu'u Hau'oki. W. M. Keck summit personnel have received natural resource training and no longer walk on the slopes of the cinder cone. Other

visitors to the site, however may not be aware of the sensitive nature of the area. Educational signs along the road would help to prevent visitors from disturbing this sensitive habitat.



Evidence of people walking in Wēkiu bug habitat in the crater of Pu'u Hau'oki. Photo taken October 14, 2005.