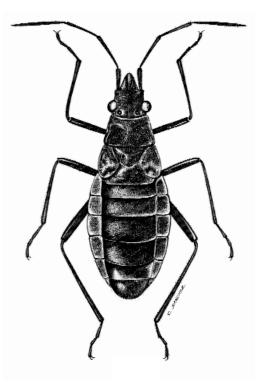
WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 3rd QUARTER 2004





Pacific Analytics, L.L.C.

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

WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 3rd QUARTER 2004

Prepared for

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



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WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 3rd QUARTER 2004

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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. 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 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 Wekiu. 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:

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

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 are installed at the summit of Mauna Kea at designated locations, ten on Pu'u Hau'oki and ten on Pu'u Wēkiu.

The 3rd Quarter 2004 three-week sampling session was conducted from August 21, 2004 through September 11, 2004. During this sampling session a total of 30 Wēkiu bugs appeared in or near the live-traps. Twenty-eight Wēkiu bugs were found on Pu'u Hau'oki and 2 were found on Pu'u Wēkiu. Trap capture rates ranged from 0.0 to 0.7 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Pu'u Hau'oki during the 3rd Quarter 2004 monitoring session was 0.4 Wēkiu bugs per trap per 3 days of sampling. This rate is about one tenth the average capture rate measured on Pu'u Hau'oki during the 3rd Quarter 2002 baseline monitoring session (4.0 WB). The 3rd Quarter 2003 trap capture rate (12.4 WB) was more than 30 times the current measured rate.

The average trap capture rate on Pu'u Hau'oki during the 2nd Quarter 2004 monitoring session was 8.8 Wēkiu bugs per trap per 3 days of sampling. The average trap capture rate on Pu'u Wēkiu during the 2nd Quarter 2004 monitoring session was 2.0 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Pu'u Hau'oki during the 1st Quarter 2004 monitoring session was 2.1 Wēkiu bugs per trap per 3 days of sampling. The average trap capture rate on Pu'u Wēkiu during the 1st Quarter 2004 monitoring session was 0.0 Wēkiu bugs per trap per 3 days of sampling.

Twenty percent (6/30) of the Wēkiu bugs captured in the 3rd Quarter 2004 sampling session were immature stages. The appearance of juvenile stages is a clear sign that Wēkiu bugs are breeding.

Wēkiu Bug Baseline Monitoring INTRODUCTION

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 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 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 monitoring activity will 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

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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 traps were established on Pu'u Hau'oki and five on Pu'u Wēkiu for this monitoring session. All of the traps deployed for Wēkiu Bug Baseline Monitoring continue to be of the improved livetrap design described in previous quarterly reports.

This is the eleventh Quarterly Report of Baseline Monitoring. The results of the sampling effort conducted August 21, 2004 through September 11, 2004 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.



Establishing new live-traps disturbs only a small amount of habitat. (Photo taken August 18, 2004 on Pu'u Hau'oki)

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

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.



Looking southeast on favorable days the active vent at Pu'u O'o can be seen from Mauna Kea. Picture taken on September 8, 2004.

Wēkiu Bug Baseline Monitoring

METHODS

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 livetraps 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.

Ten live-traps were set on Pu'u Hau'oki and Pu'u Wēkiu at the same locations where traps were installed during the previous sampling session. Five new live-traps were established on each cinder cone for reasons explained in the Discussion (Chapter VII).

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. Traps were installed at each sampling station 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.

All traps were set 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 pureed premoistened shrimp, was distributed

around the 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. 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 locations will be used for future sampling.

Traps were opened for the 3rd Quarter 2004 baseline monitoring session on August 21, 2004. The traps were checked every three days and were closed on September 11, 2004. There were no severe storms or road closures during the monitoring session.



Five new live-traps were established on the inner south slope of Pu'u Wēkiu. Picture taken August 18, 2004.

Wēkiu Bug Baseline Monitoring METHODS

Setting a Wēkiu Bug Live-Trap



Step 1 Dig Trap Hole



Step 2 Install Wire Tube



Step 3 Create Trap Apron



Step 4 Fill Reservoir



Step 5 Bait Trap



Step 6 Add Cinder Habitat



Step 7 Distribute Chum Bait



Step 8 Emplace Cap Rock

METHODS

Weather Data

In order to improve the accuracy of temperature measurements and more closely correlate them with trap capture rates, temperature data loggers were placed on each of the sampled cinder cones, Pu'u Hau'oki and Pu'u Wēkiu. The data loggers were placed near the middle of the sampled slope at the top of the ash layer and covered with native cinder to the original depth (about 4 inches). The data loggers measure and record temperature 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.

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 INFORMATION

During the 3rd Quarter 2004 baseline monitoring session there were a total of twenty-one sampling nights, making seven 3-day sampling periods.

A total of thirty Wēkiu bugs were captured, 28 on Pu'u Hau'oki and 2 on Pu'u Wēkiu. The trap capture rate (number of Wēkiu bugs per trap per 3days) ranged from 0.0 to 0.7 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 0.4 (±0.1) Wēkiu bugs for Pu'u Hau'oki, and 0.03 (±0.03) Wēkiu bugs for Pu'u Wēkiu (Table 1). For comparison, average trap capture rates from previous baseline monitoring sessions and the 1997/98 Arthropod Assessment are provided (Table 2 and Table 3). Figure 1 graphs the trap average capture rates for all Baseline Monitoring on Pu'u Hau'oki (beginning 1st Quarter 2002). Figure 2 shows the quarterly variation in average trap capture rates for Baseline Monitoring on Pu'u Hau'oki.

Overall mortality was 3% (1 of 30). Apparently the improved live-trap design is helping to reduce Wēkiu bug mortality in the live-traps.

TABLE 1. 3rd QUARTER 2004 SAMPLING PERIOD AVERAGE TRAP CAPTURE RATES The average number of Wēkiu bugs per trap per 3-days

for each sampling period during 3rd Quarter 2004 Baseline Monitoring.

Location	8/24/2004	8/27/2004	8/30/2004	9/2/2004	9/5/2004	9/8/2004	9/11/2004	AVERAGE ± SE
Pu'u W ē kiu	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03 ± 0.03
Pu'u Hau'oki	0.30	0.20	0.10	0.60	0.50	0.70	0.40	0.40 ± 0.10

Wēkiu Bug Baseline Monitoring

RESULTS

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	0.00	3.7
Pu'u Wēkiu 2004	0.00	2.0	0.03**		0.7
Pu'u Hau'oki 2002	1.0	10.3	4.0	4.0	4.8
Pu'u Hau'oki 2003	18.5	90.6	12.4	0.8	30.6
Pu'u Hau'oki 2004	2.1	8.8	0.4**		3.8

* Different trap locations on Pu'u Wēkiu in 2003

** Ten trap average

TABLE 3. SAMPLING PERIOD AVERAGE TRAP CAPTURE RATESThe average number of Wēkiu bugs per trap per 3-daysfor each sampling period during the 1997/98 Arthropod Assessment.Average trap capture rates for the 1997/98 Arthropod Assessment are in RED.

Location	Aug. 1997	Jan. 1998	April 1998	July 1998	Avg. 1997/98
Pu'u Wēkiu	0.15	0.0	0.07	0.15	0.11
Pu'u Hau'oki	0.20	0.0	0.20	1.10	0.38

Wēkiu Bug Baseline Monitoring

RESULTS

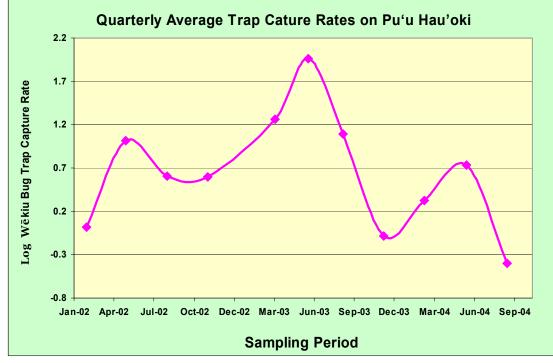


FIGURE 1. Plot of the Log Average Wēkiu Bug Trap Capture Rate per Sampling Period on Pu'u Hau'oki since Wēkiu Bug Baseline Monitoring began with the 1st Quarter 2002 sampling session.

Wēkiu Bug Baseline Monitoring

RESULTS

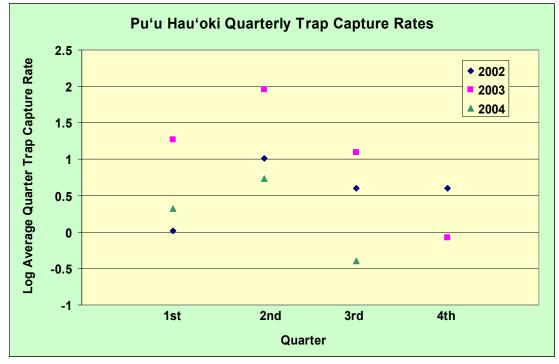


Figure 2. Pu'u Hau'oki Quarterly Average Trap Capture Rates. The log average quarterly trap capture rate of Wēkiu bugs on Pu'u Hau'oki for three years of Wēkiu Bug Baseline Monitoring.

Wēkiu Bug Baseline Monitoring

RESULTS

WEATHER INFORMATION

Figure 3 is a graph of Wekiu bug trap capture rates and temperature for the 3rd Quarter 2004 monitoring session, and uses temperature data collected from the HOBO© data There loggers. was а general indication that as average temperature increased, the Wēkiu bug trap capture rate also increased.

Graphs of previous monitoring sessions are 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 appears in Figure 4.

In previous Baseline Monitoring sessions, there was a general trend that indicated the number of Wēkiu bugs captured increased as average temperature increased. It appears from Figure 3 that Wēkiu bugs are not active below an average temperature of about -2°C.

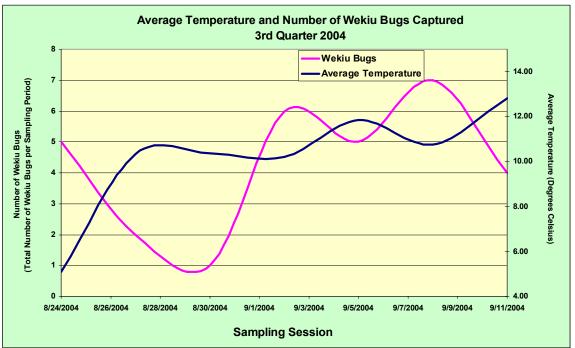


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured per Sampling Period at all sampling locations during the 3rd Quarter 2004 sampling session.

Wēkiu Bug Baseline Monitoring



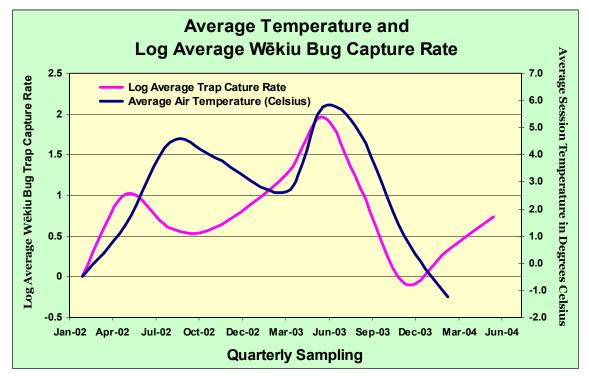


FIGURE 4. Plot of Baseline Monitoring Session Average Temperature (Celsius) and Natural Log Average Number of Wēkiu Bug Trap Capture Rate per Session on Pu'u Hau'oki.

Temperature measurements will be taken using the new data loggers and represent measurements of substrate. In past monitoring sessions, weather data was collected from near by observatories that measure air temperature near those buildings. Because the two measurements appear to be quite different, new graphs will be added that compare temperature and trap capture data (see Figure 3). Figure 4 will no longer be updated.

Wēkiu Bug Baseline Monitoring

RESULTS

Pu'u Hau'oki Inner Slope Photographic Archive

AUGUST - SEPTEMBER 2004 TRAPS 1 - 5



Pu'u Hau'oki inner slope August 21, 2004



Pu'u Hau'oki inner slope August 24, 2004



Pu'u Hau'oki inner slope August 27, 2004



Pu'u Hau'oki inner slope August 30, 2004

Wēkiu Bug Baseline Monitoring

RESULTS

TRAPS 1 - 5



Pu'u Hau'oki inner slope September 2, 2004



Pu'u Hau'oki inner slope September 5, 2004



Pu'u Hau'oki inner slope September 8, 2004

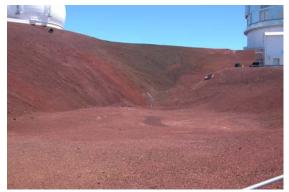


Pu'u Hau'oki inner slope September 11, 2004

Wēkiu Bug Baseline Monitoring

RESULTS

AUGUST - SEPTEMBER 2004 TRAPS 6 - 10



Pu'u Hau'oki inner slope August 21, 2004



Pu'u Hau'oki inner slope August 24, 2004



Pu'u Hau'oki inner slope August 27, 2004 Pu'u Hau'oki inner slope August 30, 2004

Wēkiu Bug Baseline Monitoring

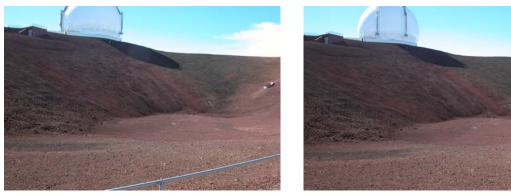
RESULTS

TRAPS 6 - 10



Pu'u Hau'oki inner slope September 2, 2004

Pu'u Hau'oki inner slope September 5, 2004



Pu'u Hau'oki inner slope September 8, 2004



Pu'u Hau'oki inner slope September 11, 2004

Wēkiu Bug Baseline Monitoring

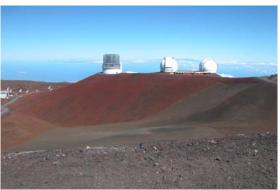
RESULTS

Pu'u Hau'oki Outer Slope Photographic Archive

AUGUST - SEPTEMBER 2004



Pu'u Hau'oki outer slope August 21, 2004



Pu'u Hau'oki outer slope August 24, 2004



Photo not Available

Pu'u Hau'oki outer slope August 27, 2004 Pu'u Hau'oki outer slope August 30, 2004

Wēkiu Bug Baseline Monitoring

RESULTS



Pu'u Hau'oki outer slope September 2, 2004



Pu'u Hau'oki outer slope September 5, 2004

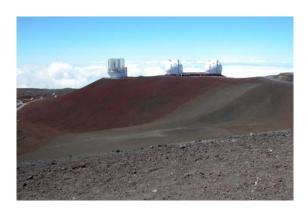


Photo not Available

Pu'u Hau'oki outer slope September 8, 2004 Pu'u Hau'oki outer slope September 11, 2004

Wēkiu Bug Baseline Monitoring

RESULTS

Pu'u Wēkiu Photographic Archive

AUGUST - SEPTEMBER 2004 TRAPS 1 - 5



Pu'u Wēkiu inner slope August 21, 2004



Pu'u Wēkiu inner slope August 24, 2004



Pu'u Wēkiu inner slope August 27, 2004



Pu'u Wēkiu inner slope August 30, 2004

Wēkiu Bug Baseline Monitoring

RESULTS

TRAPS 1 - 5



Pu'u Wēkiu inner slope September 2, 2004



Pu'u Wēkiu inner slope September 5, 2004



Photo not Available

Pu'u Wēkiu inner slope September 8, 2004 Pu'u Wēkiu inner slope September 11, 2004

Wēkiu Bug Baseline Monitoring

RESULTS

AUGUST - SEPTEMBER 2004 TRAPS 6 - 10



Pu'u Wēkiu inner slope August 21, 2004



Pu'u Wēkiu inner slope August 24, 2004



Pu'u Wēkiu inner slope August 27, 2004



Pu'u Wēkiu inner slope August 30, 2004

Wēkiu Bug Baseline Monitoring

RESULTS

TRAPS 6 - 10



Pu'u Wēkiu inner slope September 2, 2004



Pu'u Wēkiu inner slope September 5, 2004

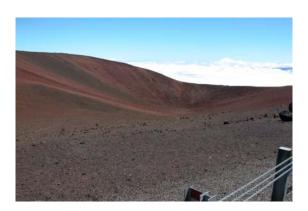


Photo not Available

Pu'u Wēkiu inner slope September 8, 2004 Pu'u Wēkiu inner slope September 11, 2004

Wēkiu Bug Baseline Monitoring

RESULTS

Pu'u Wēkiu and Hau Kea Photographic Archive

AUGUST - SEPTEMBER 2004



Pu'u Wēkiu and Hau Kea August 21, 2004



Pu'u Wēkiu and Hau Kea August 24, 2004



Pu'u Wēkiu and Hau Kea August 27, 2004



Pu'u Wēkiu and Hau Kea August 30, 2004

Wēkiu Bug Baseline Monitoring

RESULTS



Pu'u Wēkiu and Hau Kea September 2, 2004



Pu'u Wēkiu and Hau Kea September 5, 2004



Pu'u Wēkiu and Hau Kea September 8, 2004



Pu'u Wēkiu and Hau Kea September 11, 2004

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-traps 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.



Adult Wēkiu bug on cinder near a live-trap.

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 3day trapping period on Pu'u Wēkiu.

During the 1st Quarter 2004 sampling session a total of eighty-six Wēkiu bugs appeared in or near the traps. The 1st Quarter 2004 average trap capture rate was 2.1 bugs per trap per 3-day trapping period on Pu'u Hau'oki and 0.00 on Pu'u Wēkiu.

During the 2nd Quarter 2004 sampling session a total of three hundred eightythree Wēkiu bugs appeared in or near the traps. The 2nd Quarter 2004 average trap capture rate was 8.8 bugs per trap per 3-day trapping period on Pu'u Hau'oki and 2.0 on Pu'u Wēkiu.

In August 2004 permission to install 10 additional live-traps was received. Pacific Analytics personnel installed 10 additional live-traps in designated areas, five on the inner slopes of Pu'u Hau'oki and five on the inner slopes of Pu'u Wēkiu.

The Department of Land and Natural Resources (DLNR) approved the

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additional traps based on recommendations from a panel of Wēkiu bug experts that met in June 2004. The new traps are placed near the trapping locations used during the 1982 arthropod assessment and will provide a better comparison between historic and current data.

There are also statistical implications from the additional traps. Increasing the number of traps will reduce the standard errors associated with future samples enabling detection of finer differences between quarterly sampling sessions.

During the 3rd Quarter 2004 sampling session Wēkiu bugs appeared in two of ten of the traps on Pu'u Wēkiu and eight of ten traps on Pu'u Hau'oki. A total of thirty Wēkiu bugs appeared in or near the traps during the seven trapping sessions. All live bugs were released back into their habitat.

Average 3rd Quarter 2004 trap capture rate on Pu'u Hau'oki was 0.4 (±0.1) bugs per trap per 3-day trapping period. Average 3rd Quarter 2004 trap capture rate on Pu'u Wēkiu was 0.03 (±0.03) bugs per trap per 3-day trapping period.

The 3rd Quarter 2004 Wēkiu bug capture rate on Pu'u Hau'oki was one tenth the capture rate measured in the 3rd Quarter 2002 sampling session, and thirty times smaller that the capture rate measured in the 3rd Quarter 2003 sampling session (Table 2).

The 3rd Quarter 2004 Wēkiu bug capture rate on Pu'u Wēkiu was one tenth the capture rate measured in the 3rd Quarter 2002 sampling session, and sixteen times smaller that the capture rate measured in the 3rd Quarter 2003 sampling session (Table 2).

There were no construction activities or chemical spills that resulted in major habitat disturbance during 2003 and 2004 that could account for the drop in trap capture rate. The drop was apparently part of a normal cycle, or was caused by other factors that were not readily apparent.

About 20% of the Wēkiu bugs were captured in the 3rd Quarter 2004 sampling session were immature stages. During the 3rd Quarter 2002 and 2003 sampling sessions were 23% and 50% respectively. 2003 was apparently an exceptional year, with high trap capture rates and high reproductive rates. Further analysis of conditions leading up and during 2003 may provide clues about what factors may influence Wēkiu bug populations.

The average temperatures during the 3rd Quarter 2004 sampling session were measured using data loggers placed directly in the cinder. In

DERCUSSION

previous quarterly monitoring sessions, weather data was obtained from the UKIRT Observatory weather station. Since the data can not be directly compared, a new graph will be included in future quarterly monitoring reports that shows the data from the new source of information separately (Figure 3).

It is believed that using data loggers placed in the cinder substrate near the actual trapping locations provide better information about factors influencing Wēkiu bug trap capture rates. Previous data will continue to be displayed as presented in Figure 4 for comparison.

Only 3% (1 of 30) of the Wēkiu bugs captured during the 3rd Quarter 2004 sampling session did not survive. The improved live-traps appear to have reduced trapping mortality compared to the live-traps used during the 1997/98 arthropod assessment.

Other Observations

During the 3rd Quarter 2004 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.

The W. M. Keck Observatory summit crew received Natural Resource Awareness training on September 14, 2004. The training session made by Dr. Gregory Brenner of Pacific Analytics included updated information about Wēkiu bugs and other indigenous species on Mauna Kea and actions the summit crew could take to reduce or prevent impacts on the natural ecosystem. The training session lasted about 45 minutes and was attended by the entire summit crew.