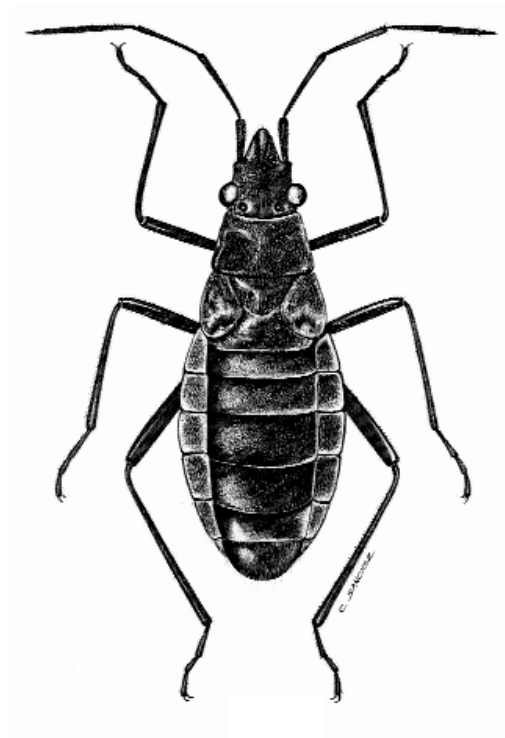


# WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT  
4<sup>th</sup> 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**  
**4<sup>th</sup> QUARTER 2004**

Prepared for

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



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# WĒKIU BUG BASELINE MONITORING

## QUARTERLY REPORT 4<sup>th</sup> QUARTER 2004

### I. TABLE OF CONTENTS

	Page
I. TABLE OF CONTENTS .....	1
II. EXECUTIVE SUMMARY .....	2
III. INTRODUCTION .....	5
IV. QUESTIONS OF INTEREST .....	7
V. METHODS .....	9
VI. RESULTS .....	13
VII. DISCUSSION .....	31

## 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 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 Wēkiu bug habitat was approved to establish baseline population estimates of the Wēkiu 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?









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### Wēkiu Bug Baseline Monitoring INTRODUCTION

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

trap design described in previous quarterly reports.

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 live-

This is the twelfth Quarterly Report of Baseline Monitoring. The results of the sampling effort conducted October 07, 2004 through October 28, 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.



Snow fell during the last days of 4<sup>th</sup> Quarter 2004 monitoring  
(Photo taken October 28, 2004 from Pu'u Wēkiu)

#### 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  
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 live-traps that cause minimal disturbance to species and their habitats. Non-destructive 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.

Twenty 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.

**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, 1/2" 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 pre-moistened 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



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





Wēkiu Bug Baseline Monitoring  
**RESULTS**

## VI. RESULTS

### SAMPLING INFORMATION

During the 4<sup>th</sup> Quarter 2004 baseline monitoring session there were a total of twenty-one sampling nights, making seven 3-day sampling periods.

A total of nineteen Wēkiu bugs were captured, fifteen on Pu'u Hau'oki and four on Pu'u Wēkiu. The trap capture rate (number of Wēkiu bugs per trap per 3-days) ranged from 0.0 to 1.0 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 0.21 ( $\pm 0.14$ ) Wēkiu bugs for Pu'u Hau'oki, and 0.06 ( $\pm 0.04$ ) 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 1<sup>st</sup> Quarter 2002). Figure 2 shows the quarterly variation in average trap capture rates for Baseline Monitoring on Pu'u Hau'oki.

Overall mortality was 10% (2 of 19). Apparently the improved live-trap design is helping to reduce Wēkiu bug mortality in the live-traps.

**TABLE 1.**  
**4<sup>th</sup> QUARTER 2004 SAMPLING PERIOD**  
**AVERAGE TRAP CAPTURE RATES**  
 The average number of Wēkiu bugs per trap per 3-days  
 for each sampling period during 4<sup>th</sup> Quarter 2004 Baseline Monitoring.

Location	10/10/2004	10/13/2004	10/16/2004	10/19/2004	10/22/2004	10/25/2004	10/28/2004	AVERAGE $\pm$ SE
Pu'u Wēkiu	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.06 $\pm$ 0.04
Pu'u Hau'oki	1.00	0.20	0.10	0.20	0.00	0.00	0.00	0.21 $\pm$ 0.14

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 <sup>st</sup> Quarter	2 <sup>nd</sup> Quarter	3 <sup>rd</sup> Quarter	4 <sup>th</sup> Quarter	Year Avg.
Pu'u Wēkiu 2002*	0.03	0.03	0.3	0.2	<b>0.1</b>
Pu'u Wēkiu 2003	2.8	11.5	0.5	0.0	<b>3.7</b>
Pu'u Wēkiu 2004	0.00	2.0	0.03**	<b>0.06**</b>	<b>0.5</b>
Pu'u Hau'oki 2002	1.0	10.3	4.0	4.0	<b>4.8</b>
Pu'u Hau'oki 2003	18.5	90.6	12.4	0.8	<b>30.6</b>
Pu'u Hau'oki 2004	2.1	8.8	0.4**	<b>0.21**</b>	<b>2.9</b>

\* Different trap locations on Pu'u Wēkiu in 2002

\*\* Ten trap average

**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 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	<b>0.11</b>
Pu'u Hau'oki	0.20	0.0	0.20	1.10	<b>0.38</b>

Wēkiu Bug Baseline Monitoring  
 RESULTS

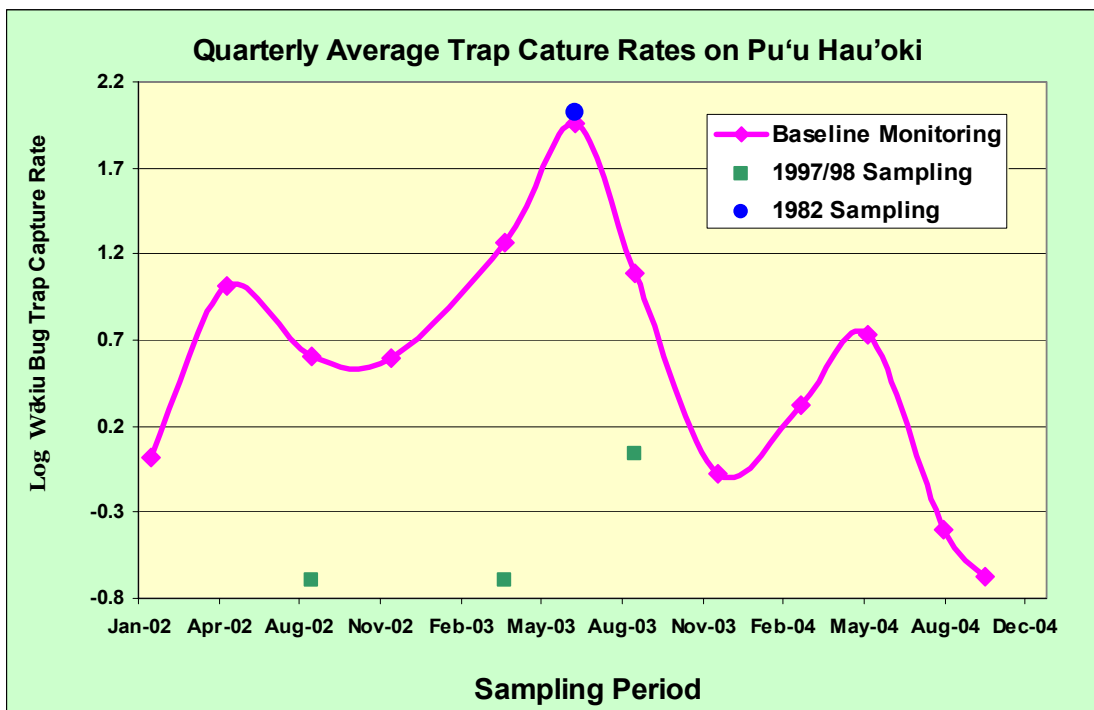


FIGURE 1. Graph of the Log Average Wēkiu Bug Trap Capture Rate per Sampling Period on Pu'u Hau'oki since Wēkiu Bug Baseline Monitoring began with the 1st Quarter 2002 sampling session. Points of 1982 and 1998/97 sampling on Pu'u Hau'oki are included.

Wēkiu Bug Baseline Monitoring  
RESULTS

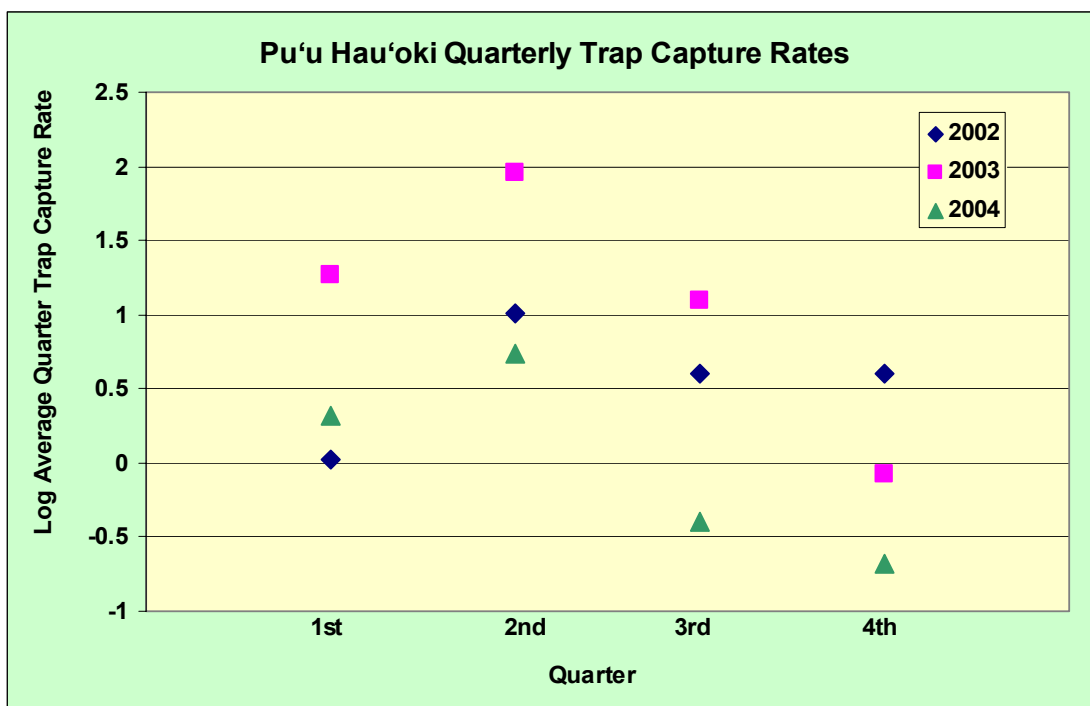


Figure 2. Pu'u Hau'oki Quarterly Average Trap Capture Rates. The log average quarterly trap capture rate of Wēkiu bugs on Pu'u Hau'oki for three years of Wēkiu Bug Baseline Monitoring.

**Wēkiu Bug Baseline Monitoring  
RESULTS**

**WEATHER INFORMATION**

Figure 3 is a graph of Wēkiu bug trap capture rates and temperature for the 4<sup>th</sup> Quarter 2004 monitoring session, and uses temperature data collected from the HOBO® data loggers. There was a general indication that as average temperature decreased, the number of Wēkiu bugs in the traps also decreased.

was not available for the 2<sup>nd</sup> 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.

Graphs of previous monitoring sessions are based on temperature data collected by the UKIRT Observatory. Weather information

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

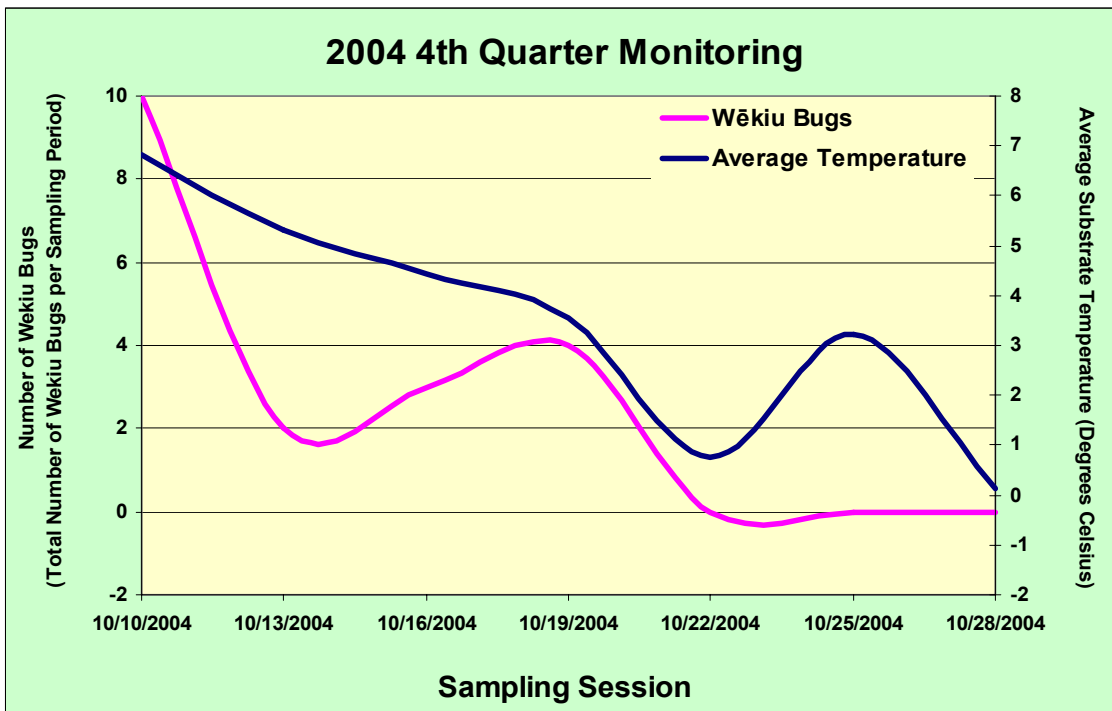
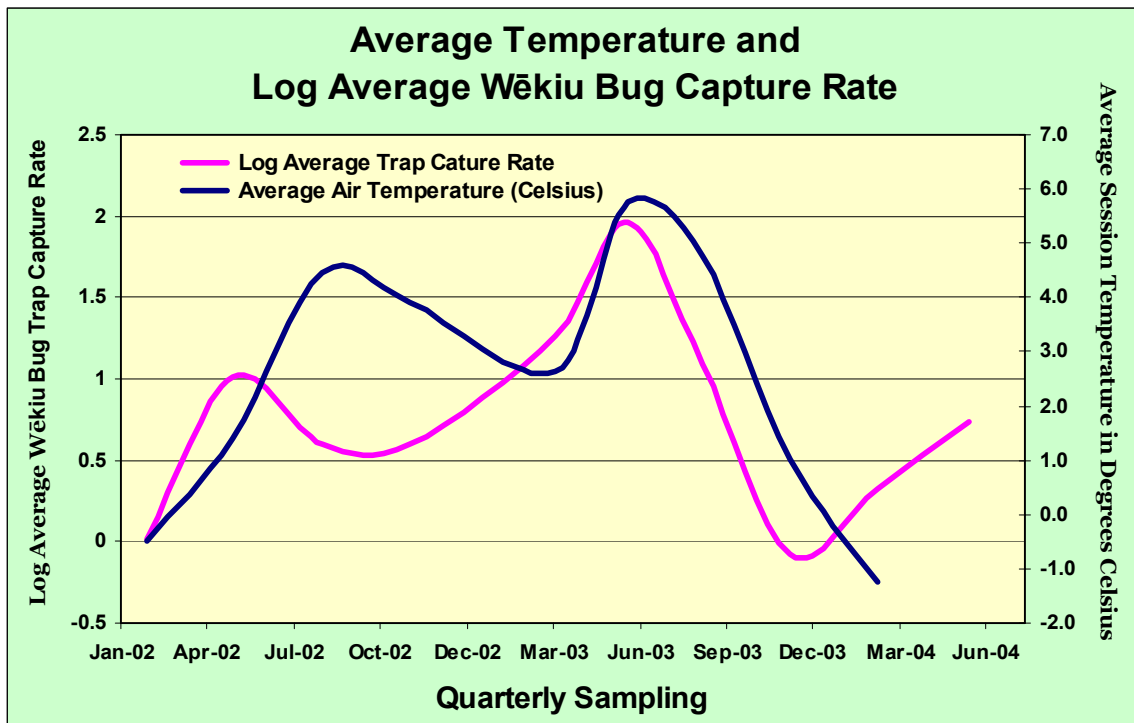


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured per Sampling Period at all sampling locations during the 4<sup>th</sup> Quarter 2004 sampling session.

**Wēkiu Bug Baseline Monitoring  
RESULTS**



**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 in all future monitoring sessions and will represent measurements of substrate temperature. 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 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

OCTOBER 2004  
TRAPS 1 - 5



Pu'u Hau'oki inner slope  
October 07, 2004



Pu'u Hau'oki inner slope  
October 10, 2004



Pu'u Hau'oki inner slope  
October 13, 2004



Pu'u Hau'oki inner slope  
October 16, 2004

Wēkiu Bug Baseline Monitoring  
RESULTS

TRAPS 1 - 5



Pu'u Hau'oki inner slope  
October 19, 2004



Pu'u Hau'oki inner slope  
October 22, 2004



Pu'u Hau'oki inner slope  
October 25, 2004

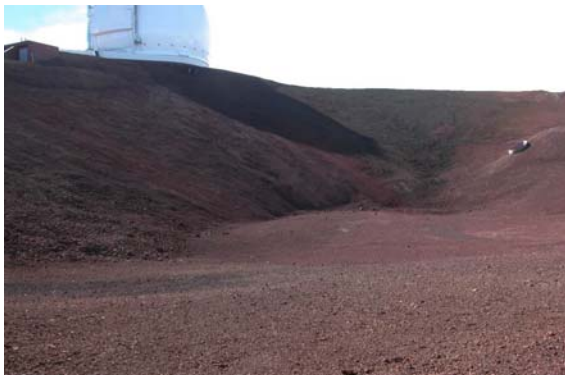


Pu'u Hau'oki inner slope  
October 28, 2004

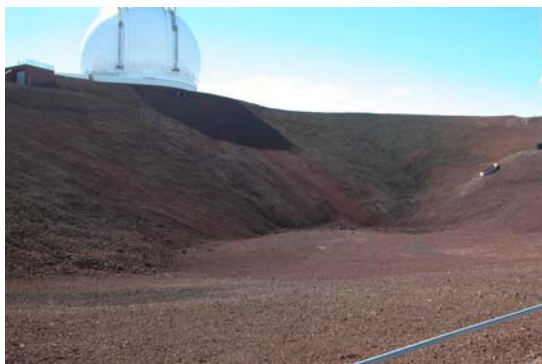


Wēkiu Bug Baseline Monitoring  
RESULTS

OCTOBER 2004  
TRAPS 6 - 10



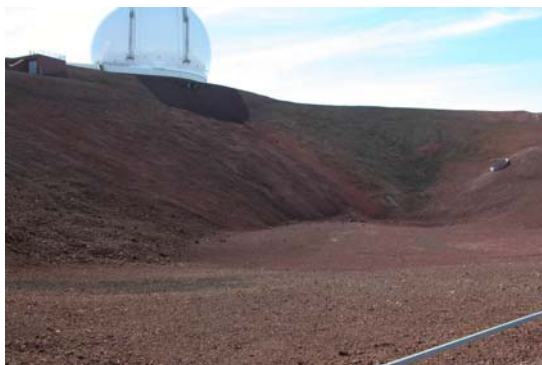
Pu'u Hau'oki inner slope  
October 07, 2004



Pu'u Hau'oki inner slope  
October 10, 2004



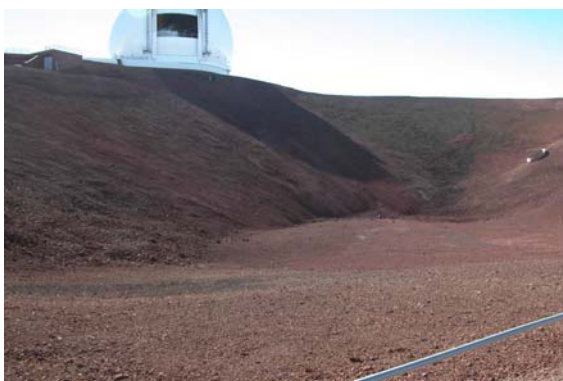
Pu'u Hau'oki inner slope  
October 13, 2004



Pu'u Hau'oki inner slope  
October 16, 2004

Wēkiu Bug Baseline Monitoring  
RESULTS

TRAPS 6 - 10



Pu'u Hau'oki inner slope  
October 19, 2004



Pu'u Hau'oki inner slope  
October 22, 2004



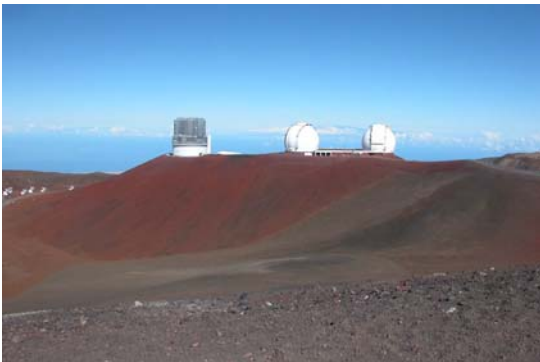
Pu'u Hau'oki inner slope  
October 25, 2004



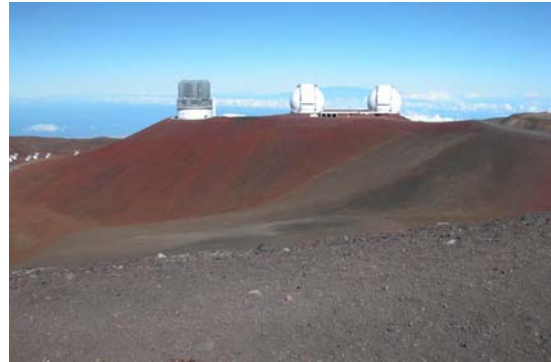
Pu'u Hau'oki inner slope  
October 28, 2004

Pu'u Hau'oki Outer Slope Photographic Archive

OCTOBER 2004



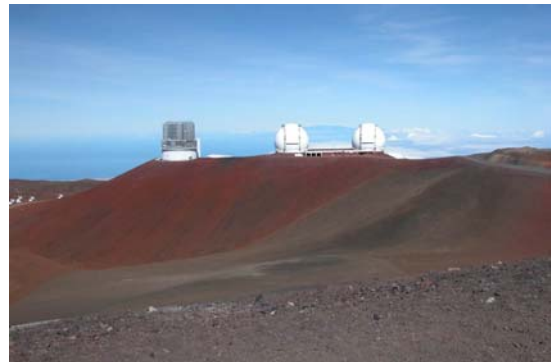
Pu'u Hau'oki outer slope  
October 07, 2004



Pu'u Hau'oki outer slope  
October 10, 2004



Pu'u Hau'oki outer slope  
October 13, 2004



Pu'u Hau'oki outer slope  
October 16, 2004













**Pu‘u Wēkiu and Hau Kea Photographic Archive**

**OCTOBER 2004**



**Pu‘u Wēkiu and Hau Kea  
October 07, 2004**



**Pu‘u Wēkiu and Hau Kea  
October 10, 2004**



**Pu‘u Wēkiu and Hau Kea  
October 13, 2004**



**Pu‘u Wēkiu and Hau Kea  
October 16, 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 3-day trapping period on Pu'u Wēkiu.

During the 1<sup>st</sup> Quarter 2004 sampling session a total of eighty-six Wēkiu bugs appeared in or near the traps. The 1<sup>st</sup> 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 2<sup>nd</sup> Quarter 2004 sampling session a total of three hundred eighty-three Wēkiu bugs appeared in or near the traps. The 2<sup>nd</sup> 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.

During the 3<sup>rd</sup> Quarter 2004 sampling session a total of thirty Wēkiu bugs appeared in or near the traps. The 3<sup>rd</sup> Quarter 2004 average trap capture rate was 0.40 bugs per trap per 3-day trapping period on Pu'u Hau'oki and 0.03 bugs per trap per 3-day trapping period on Pu'u Wēkiu.

Wēkiu Bug Baseline Monitoring  
DISCUSSION

During the 4<sup>th</sup> Quarter 2004 sampling session Wēkiu bugs appeared in two of ten of the traps on Pu'ū Wēkiu and seven of ten traps on Pu'ū Hau'oki. A total of nineteen Wēkiu bugs appeared in or near the traps during the seven trapping sessions. All live bugs were released back into their habitat.

Average 4<sup>th</sup> Quarter 2004 trap capture rate on Pu'ū Hau'oki was 0.21 ( $\pm 0.14$ ) bugs per trap per 3-day trapping period. Average 4<sup>th</sup> Quarter 2004 trap capture rate on Pu'ū Wēkiu was 0.06 ( $\pm 0.04$ ) bugs per trap per 3-day trapping period.

The 4<sup>th</sup> Quarter 2004 Wēkiu bug capture rate on Pu'ū Hau'oki was one twentieth the capture rate measured in the 4<sup>th</sup> Quarter 2002 sampling session, and one fourth the capture rate measured in the 4<sup>th</sup> Quarter 2003 sampling session (Table 2).

The 4<sup>th</sup> Quarter 2004 Wēkiu bug capture rate on Pu'ū Wēkiu was one third the capture rate measured in the 4<sup>th</sup> Quarter 2002 sampling session. No Wēkiu bugs were captured on Pu'ū Wēkiu during the 4<sup>th</sup> Quarter 2003 sampling session (Table 2).

It is interesting that the number of Wēkiu bugs captured has dropped off drastically since 2003. There have been 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 decline is apparently part of a normal cycle, or was caused by other factors that were not readily apparent.

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

About 16% of the Wēkiu bugs captured in the 4<sup>th</sup> Quarter 2004 sampling session were immature stages. During the 4<sup>th</sup> Quarter 2002 sampling session immature stages accounted for 21%. No immature stages were collected during the 4<sup>th</sup> Quarter 2003 sampling session.

Temperatures during the 4<sup>th</sup> Quarter 2004 sampling session were measured using data loggers placed directly in the cinder. In 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 show 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 10% (2 of 19) of the Wēkiu bugs captured during the 4<sup>th</sup> 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 4<sup>th</sup> 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.



Trash collected from the WMKO is transported to the Waimea for disposal.

Use of off-road vehicles is not permitted to on the Mauna Kea Science Reserve. It is important to protect remaining habitat from further disturbance.



Off-road vehicles transported to the parking area near Lake Waiau..

The University Of Hawaii Board Of Regents toured the WMKO facility and viewed the proposed locations of the Outrigger Telescopes.



UH Board of Regents with IfA and OMKM officials at the WMKO site. .