

WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT
2nd QUARTER 2003

Prepared for

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

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WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 2nd QUARTER 2003

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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 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?

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

This is the sixth Quarterly Report of Baseline Monitoring. The results of

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
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
METHODS

Weather Data

Daily weather data from the UKIRT Observatory on the summit of Mauna Kea was downloaded from the Internet/World Wide Web at *www.maunakeaweather.hawaii.edu*. The UKIRT Observatory is located on Pu'u Kea adjacent to the Pu'u Wēkiu sampling sites, and is less than one-half mile away from the Pu'u Hau 'Oki sampling sites.

Average temperature, average wind-chill temperature, average barometric pressure, and average humidity were

calculated for each 3-day sampling session from the UKIRT Observatory weather data. Minimum and maximum temperatures for the 3-day sampling sessions were also noted from the data.

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 changes in Wēkiu bug habitats through time.



Checking a live-trap on Pu'u Wēkiu, June 18, 2003.

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 Wekiu 2002	0.03	0.03	0.26	0.17	0.12
Pu'u Wekiu 2003*	2.87	11.5			7.20
Pu'u Hau 'Oki 2002	0.99	9.56	4.01	3.97	4.63
Pu'u Hau 'Oki 2003	18.29	90.6			54.53

* Different trap locations on Pu'u Wēkiu in 2003

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 Wekiu	0.15	0	0.07	0.15	0.11
Pu'u Hau 'Oki	0.2	0	0.2	1.1	0.38

**Wēkiu Bug Baseline Monitoring
RESULTS**

WEATHER INFORMATION

The number of Wēkiu bugs found in traps was plotted with average temperature during the 3-day sampling periods. The pattern reveals that during the 2nd Quarter 2003 sampling session the number of Wēkiu bugs varies considerably with average temperature.

In previous Baseline Monitoring sessions, there was a general trend that indicated the number of Wēkiu bugs captured increased as average temperature increased (Figure 2, Figure 3, Figure 4, Figure 5, and Figure 6). That trend is not as apparent in this session (Figure 1).

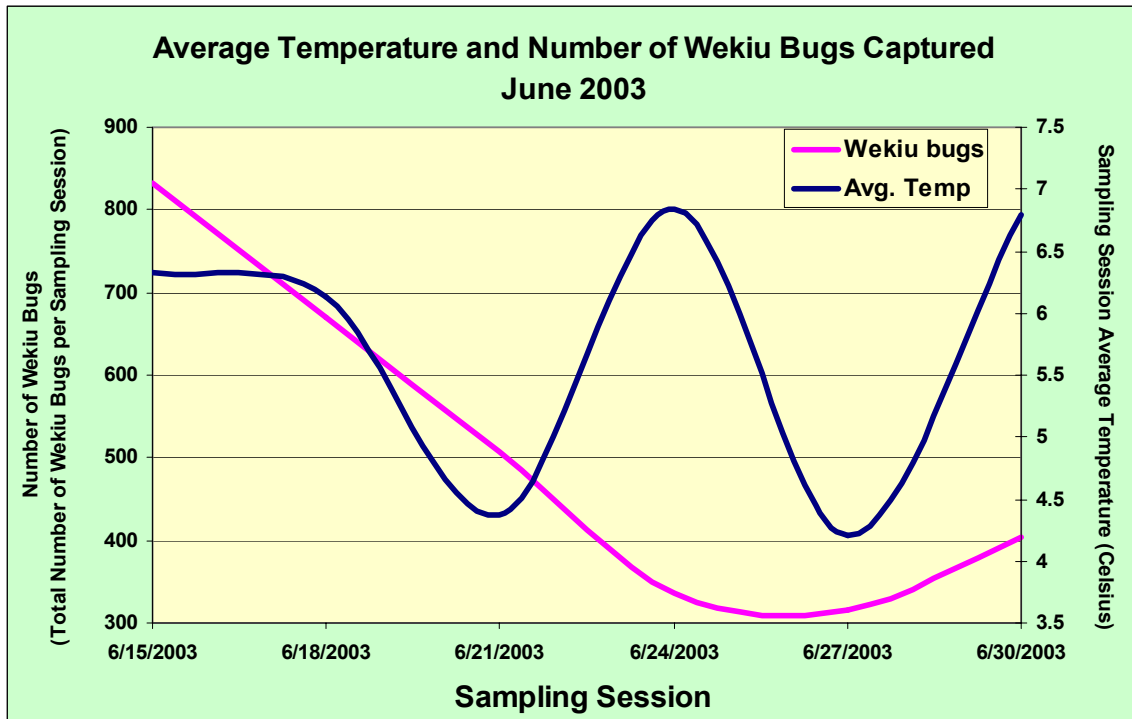


FIGURE 1. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in June 2003.

**Wēkiu Bug Baseline Monitoring
RESULTS**

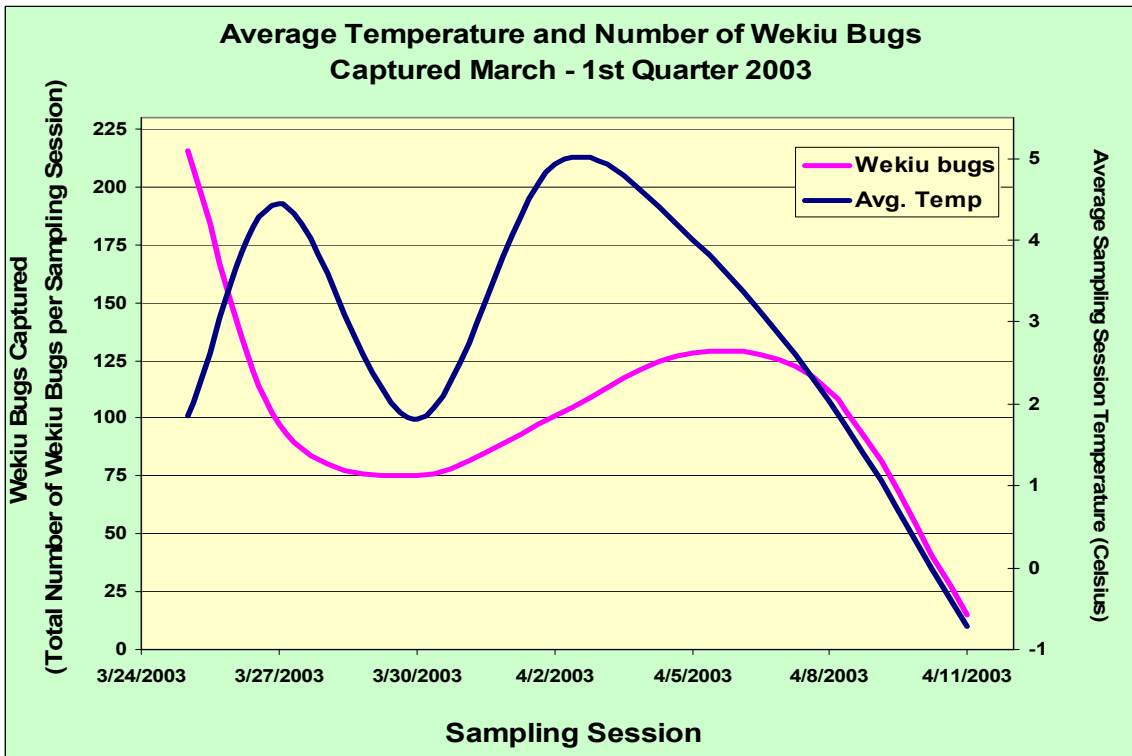


FIGURE 2. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in March – April 2003.

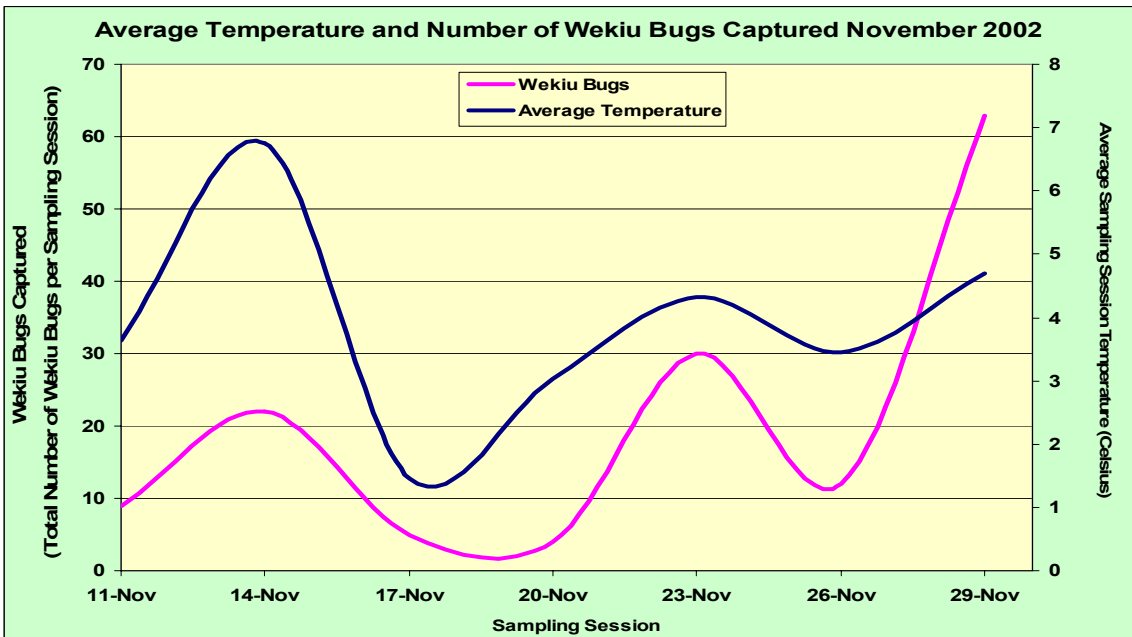


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in November 2002.

**Wēkiu Bug Baseline Monitoring
RESULTS**

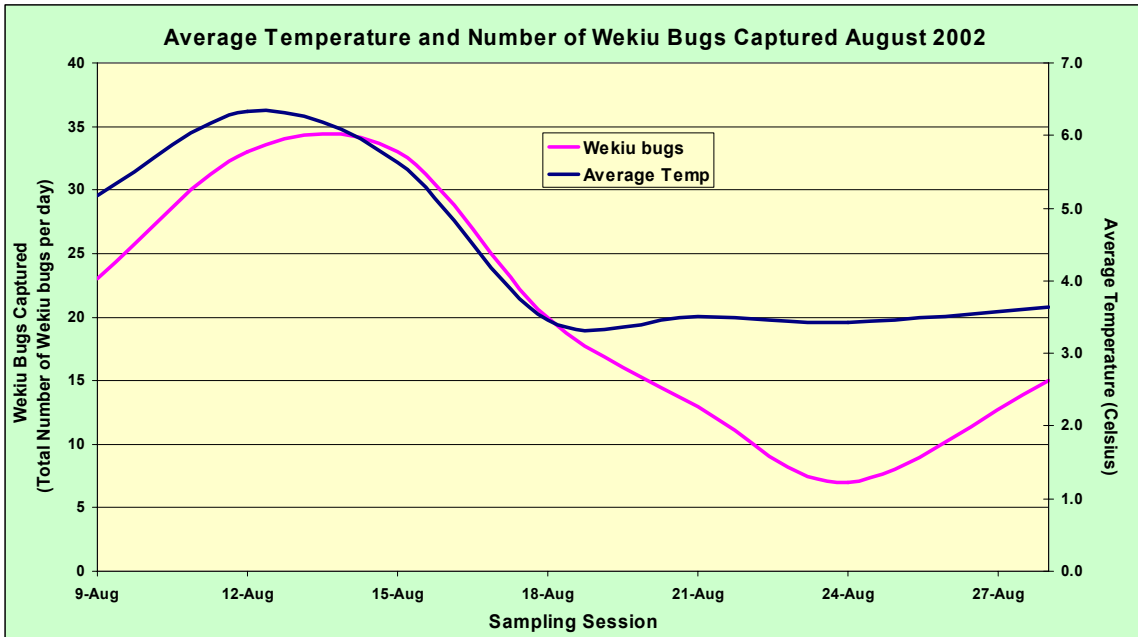


FIGURE 4. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in August 2002.

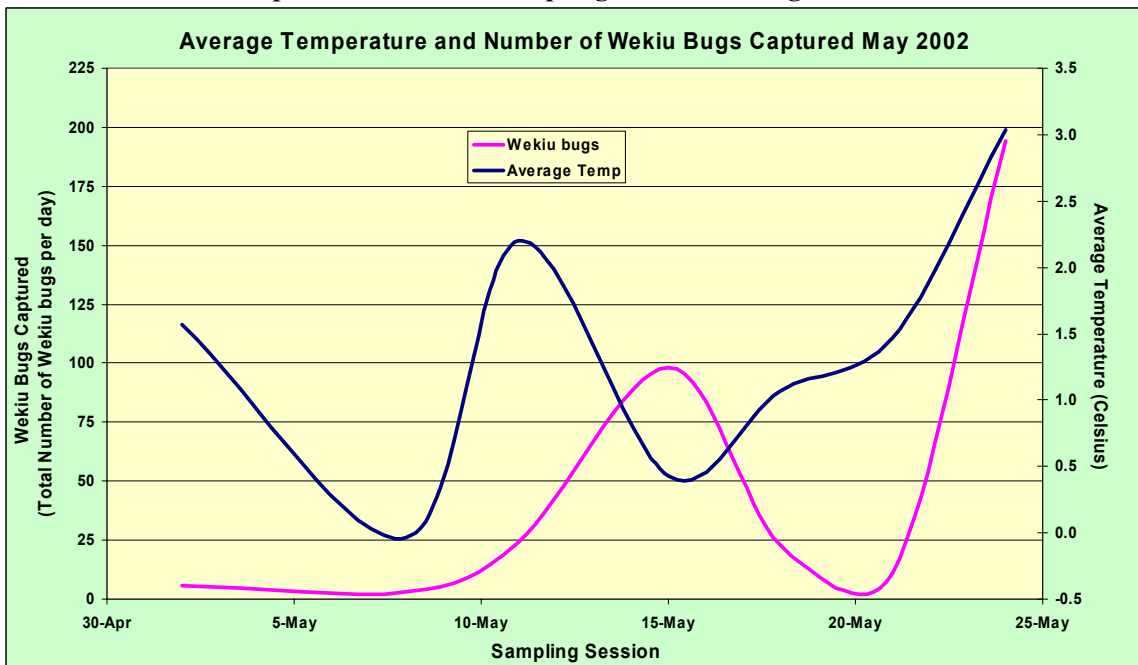


FIGURE 5. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in May 2002.

Wēkiu Bug Baseline Monitoring
RESULTS

Pu'u Hau 'Oki Inner Slope Photographic Archive

JUNE 2003



**Pu'u Hau 'Oki inner slope
June 12, 2003**



**Pu'u Hau 'Oki inner slope
June 15, 2003**



**Pu'u Hau 'Oki inner slope
June 18, 2003**



**Pu'u Hau 'Oki inner slope
June 21, 2003**

Wēkiu Bug Baseline Monitoring
RESULTS



**Pu'u Hau 'Oki inner slope
June 24, 2003**



**Pu'u Hau 'Oki inner slope
June 27, 2003**

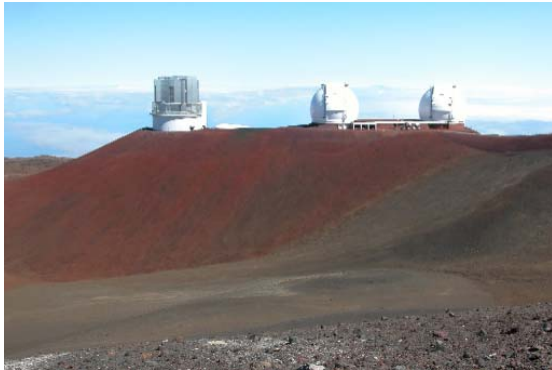


**Pu'u Hau 'Oki inner slope
June 30, 2003**

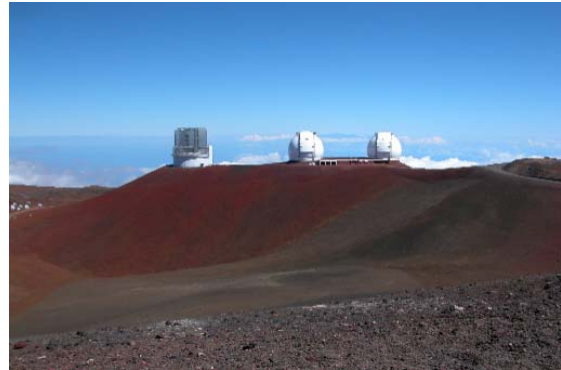
Wēkiu Bug Baseline Monitoring
RESULTS

Pu'u Hau 'Oki Outer Slope Photographic Archive

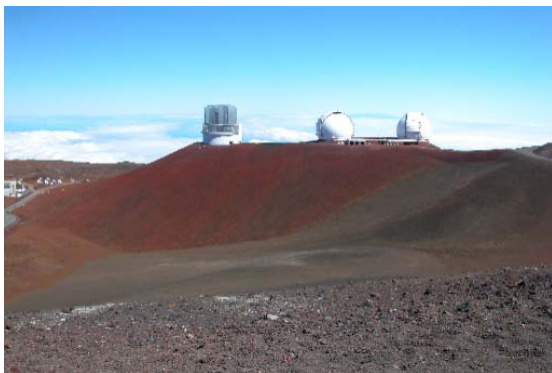
JUNE 2003



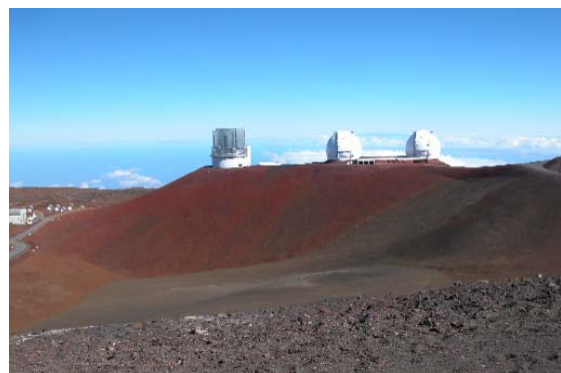
**Pu'u Hau 'Oki outer slope
June 12, 2003**



**Pu'u Hau 'Oki outer slope
June 15, 2003**

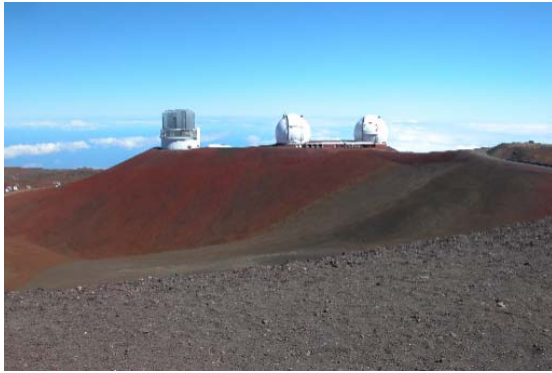


**Pu'u Hau 'Oki outer slope
June 18, 2003**

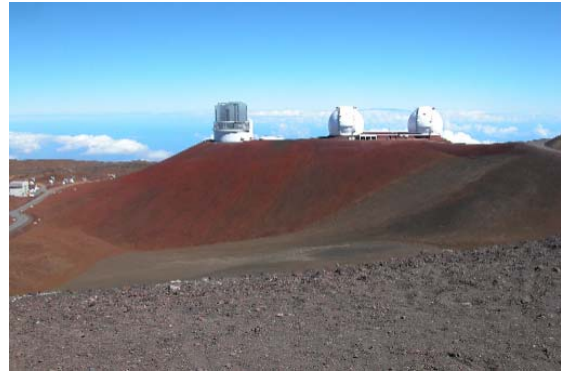


**Pu'u Hau 'Oki outer slope
June 21, 2003**

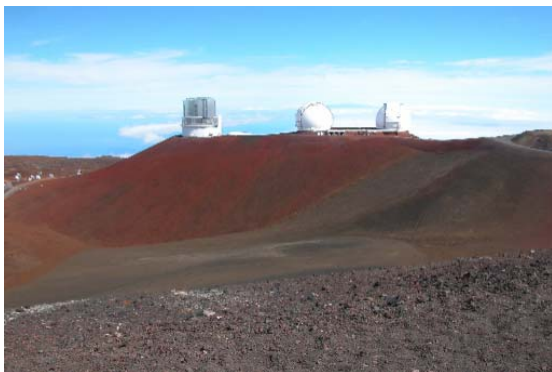
Wēkiu Bug Baseline Monitoring
RESULTS



**Pu'u Hau 'Oki outer slope
June 24, 2003**



**Pu'u Hau 'Oki outer slope
June 27, 2003**



**Pu'u Hau 'Oki outer slope
June 30, 2003**

Pu'u Wēkiu Photographic Archive

Wēkiu Bug Baseline Monitoring
RESULTS

Pu'u Wēkiu and Hau Kea Photographic Archive

JUNE 2003



Pu'u Wēkiu and Hau Kea
June 12, 2003



Pu'u Wēkiu and Hau Kea
June 15, 2003



Pu'u Wēkiu and Hau Kea
June 18, 2003



Pu'u Wēkiu and Hau Kea
June 21, 2003

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, 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 4.63 bugs per trap per 3-day trapping period on Pu‘u Hau ‘Oki, and 0.12 bugs per trap per 3-day trapping period on Pu‘u Wēkiu. During the 2003 1st Quarter sampling session a total of seven

hundred and twelve Wēkiu bugs appeared in or near the traps. The 2003 1st Quarter average trap capture rate was 18.29 Wēkiu bugs per trap per 3 days of sampling on Pu‘u Hau ‘Oki and 2.87 on Pu‘u Wēkiu (Table 2).

The 2003 2nd Quarter 3-week sampling session was conducted from June 12, 2003 to June 30, 2003 with samples acquired every three days (six samples per trap).

During the 2003 2nd Quarter sampling session Wēkiu bugs appeared in all ten of the traps, and a total of three thousand and sixty-three Wēkiu bugs appeared in or near the traps during the six trapping sessions. About eighty-eight percent (2,717 Wēkiu bugs) of the Wēkiu bugs captured appeared in live-traps on Pu‘u Hau ‘Oki. Three hundred and forty-six Wēkiu bugs appeared in live-traps on Pu‘u Wēkiu. All live bugs were released back into their habitat.

Average 2nd Quarter 2003 trap capture rate on Pu‘u Hau ‘Oki was 90.6 bugs per trap per 3-day trapping period. Average 2nd Quarter 2003 trap capture rate on Pu‘u Wēkiu was 11.5 bugs per trap per 3-day trapping period. During the July 1998 sampling period

Wēkiu Bug Baseline Monitoring
DISCUSSION

of the 1997/98 Arthropod Assessment trap capture rates averaged 1.1 on Pu'u Hau 'Oki and 0.15 on Pu'u Wēkiu (Table 3). Trap capture rates in 2003 represented an increase of at least 75 times that measured in 1998. Apparently, Wēkiu bug populations may have increased since 1998.

The 2003 2nd Quarter Wēkiu bug capture rate was about nine times the capture rate measured in May 2002, the period of highest Wēkiu bug measured in 2002. The majority of Wēkiu bugs captured in the 2nd Quarter 2003 sampling session were immature. The average adult trap capture rate on Pu'u Hau 'Oki was 16.5 per trap per 3-day trapping period during the 2nd Quarter 2003 monitoring and 10.1 during the 2nd Quarter 2002 monitoring. It appears that adult Wēkiu bugs are more active in May and June than during any other period of the year.

The average trap capture rate on Pu'u Wēkiu during the 2003 2nd Quarter sampling was eighty-two times greater than the 2002 overall average (Table 2). Because of disturbance, traps on Pu'u Wēkiu were relocated to previously approved sites along the Col trail. This probably accounts for some of the increase in trap capture rates.

Unfortunately not all Wēkiu bugs survived in live-traps. In 2002

sampling, mortality averaged about 16%. In an effort to reduce mortality, a modification was made to the trap and tested during the 1st Quarter 2003 sampling session. Trap mortality dropped to less than 9% in modified traps during that session. The modified live-traps were used exclusively during the 2nd Quarter 2003 sampling session and mortality decreased to less than 2%. Other factors may contribute to the decrease, including weather conditions.



Immature Wēkiu bugs hide in holes in the cinders.

About 80% of the Wēkiu bugs captured during this sampling session were juveniles, many of them early instar nymphs. Apparently, Wēkiu bugs are breeding. In August and November 2002, nearly 23% and 18% (respectively) of all Wēkiu bugs captured were juveniles. Conditions were presumably right for hatching. This is useful information for habitat managers and helps to clarify the

Wēkiu Bug Baseline Monitoring
DISCUSSION

Wēkiu bug life cycle and population dynamics.

Weather Data

The number of Wēkiu bugs captured in live-traps seems to vary with average air temperature (Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, and Figure 6). Generally, higher trap captures occur when average air temperature is higher, and drop off when air temperature is lower. More information will need to be collected before conclusive inferences can be made about Wēkiu bug response to changes in air temperature, however the information gathered during the Baseline Monitoring in 2002 and 2003 sampling sessions is consistent with the hypothesis that Wēkiu bug activity may be somewhat regulated by temperature.



Wasp that appeared in live-trap.

Other Observations

During the 2nd Quarter 2003 monitoring session the site was free of loose trash and debris. Observatory vehicles parked near the WMKO were clean and free of mud and had no visible signs of alien arthropods.

During May 2003 the Temporary Optics Test Sites (TOTS) at the WMKO were decommissioned and removed. This required several large pieces of equipment, including a backhoe, generator, and trailers to transport them to the site. At the site it was necessary to move some cinder to access the TOTS and cover the remains of their foundations.

To prevent damage to Wēkiu bugs and their habitat during the TOTS removal, Observatory personnel followed all the pertinent recommendations set forth in the Wēkiu Bug Mitigation Plan prepared for the Outrigger Telescopes project. These recommendations were reviewed by the U.S. Fish and Wildlife Service and judged as adequate protection measures for that larger project.

The following recommendations were used to guide the removal of the TOTS.

Wēkiu Bug Baseline Monitoring
DISCUSSION

were covered with tarps to prevent dust from being transported onto Wēkiu bug habitat.

ALIEN SPECIES CONTROL

Recommendation VIII-1: Earthmoving equipment should be free of large deposits of soil, dirt and vegetation debris that may harbor alien arthropods.



Pressure-washed tractor at the site.

(a) Pressure-wash to remove alien arthropods.

Trucks, trailers, and earthmoving equipment were cleaned and free of soil deposits that could harbor alien arthropods.

(c) Inspect large trucks, tractors, and other heavy equipment before proceeding up the observatory road.



Undercarriage of trailer used to transport backhoe was cleaned and free of soil and dirt.

Trucks, trailers, and earthmoving equipment were inspected for alien arthropods at the Saddle Road before they proceeded up the observatory access road.



A crane is inspected for soil, dirt, and vegetation and arthropods that may potentially harm Wēkiu bugs and other endemic arthropod species.