

WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 1st QUARTER 2003

Prepared for

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

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WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 1st QUARTER 2003

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	26

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
EXECUTIVE SUMMARY

the live-traps. Six hundred and eight were found on Pu'u Hau 'Oki, and one hundred on Pu'u Wēkiu. Trap capture rates ranged from zero to 43.6 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Pu'u Hau 'Oki during the 1st Quarter 2003 monitoring session was 18.29 (± 4.79) Wēkiu bugs per trap per 3 days of sampling. This rate is about seventeen times greater than the average capture rate measured on Pu'u Hau 'Oki during the 1st Quarter baseline monitoring session in February 2002, and about 80% greater than measured during the 2nd Quarter baseline monitoring session in May 2002.

The average trap capture rate on Pu'u Wēkiu during the 1st Quarter 2003 monitoring session was 2.87 (± 1.03) Wēkiu bugs per trap per 3 days of sampling. This rate is about 94 times greater than the average capture rate measured on Pu'u Wēkiu during the 1st Quarter baseline monitoring session in February 2002. These rates cannot be directly compared because trap locations changed on Pu'u Wēkiu in 2003.

Seventy-nine (11%) of the Wēkiu bugs captured during the 1st Quarter 2003 monitoring session were juveniles, an indication that the population is breeding.



Adult Wēkiu bug found in live-traps on Pu'u Hau 'Oki.
Actual size is about ¼ inch (~5 mm).

Photo by Jeffrey C. Miller
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Wēkiu Bug Baseline Monitoring
INTRODUCTION

the sampling effort conducted March 22, 2003 through April 11, 2003 are reported. Comparisons to previously collected data will be presented, along

with new analysis and interpretations of correlations of changes in Wēkiu bug populations with weather related phenomena.



Photo by Jeffrey C. Miller
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Immature Wēkiu bugs found on Pu‘u Hau ‘Oki near the summit of Mauna Kea. Actual size is less than 1/4 inch (~3 mm).

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.



Photo by Jeffrey C. Miller
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Lycosid spider found in Live Trap on Pu‘u Wēkiu.
 Actual size is about 1 ½ inches (~40 mm).

Wēkiu Bug Baseline Monitoring
METHODS

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 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 bugs 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 2003 first baseline monitoring session on March 22, 2003. The traps were checked every three days and were closed on April 11, 2003.



Red arrow points to live-trap buried by recent snow fall. Traps buried by snow generally do not capture many Wēkiu bugs. Photo taken April 11, 2003.

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.



During snow events live-traps can fill with wind-blown snow, making it possible for Wēkiu bugs to escape from the traps. Photo taken April 11, 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				2.87
Pu'u Hau Ok 2002	0.99	9.56	4.01	3.97	4.63
Pu'u Hau Ok 2003	18.29				18.29

* 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 1ST Quarter 2003 sampling session the number of Wēkiu bugs varies considerably with average temperature.

Generally, as average temperature increases, the number of Wēkiu bugs captured also increases (Figure 1). This is similar to the general pattern found during the 2002 Baseline Monitoring sampling sessions (Figure 2, Figure 3, Figure 4, and Figure 5).

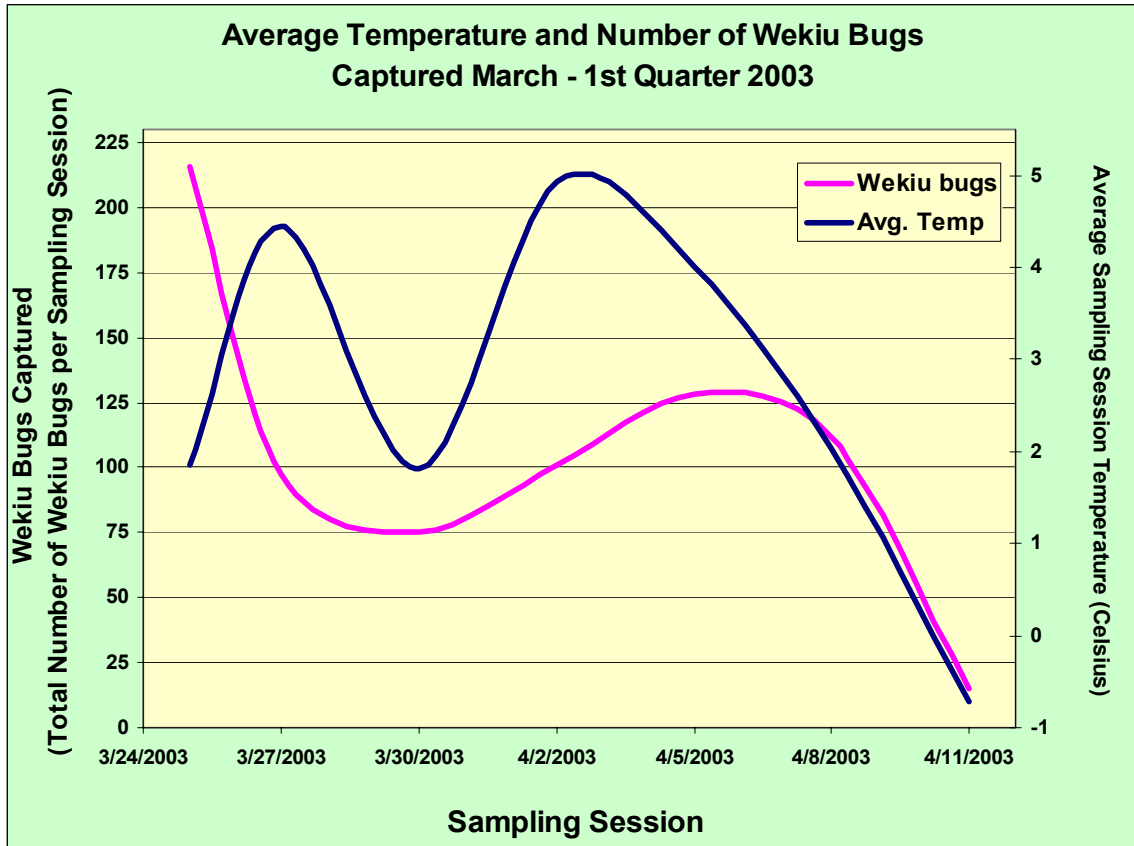


FIGURE 1. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in March – April 2003.

**Wēkiu Bug Baseline Monitoring
RESULTS**

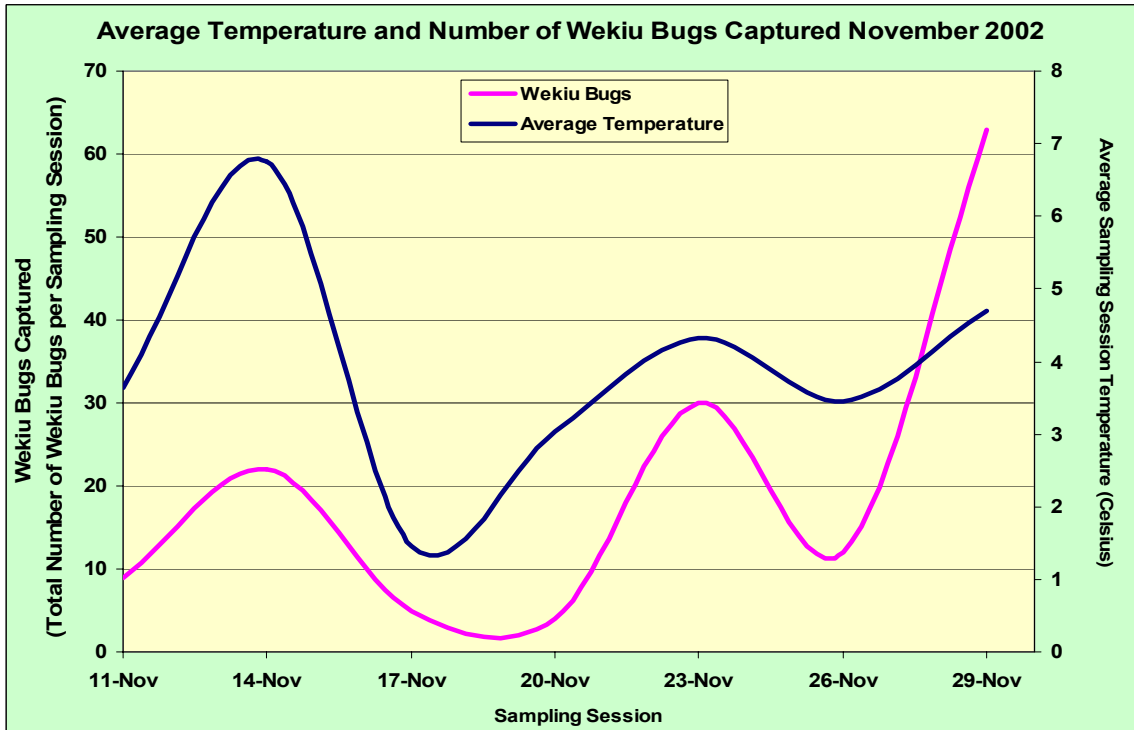


FIGURE 2. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in November 2002.

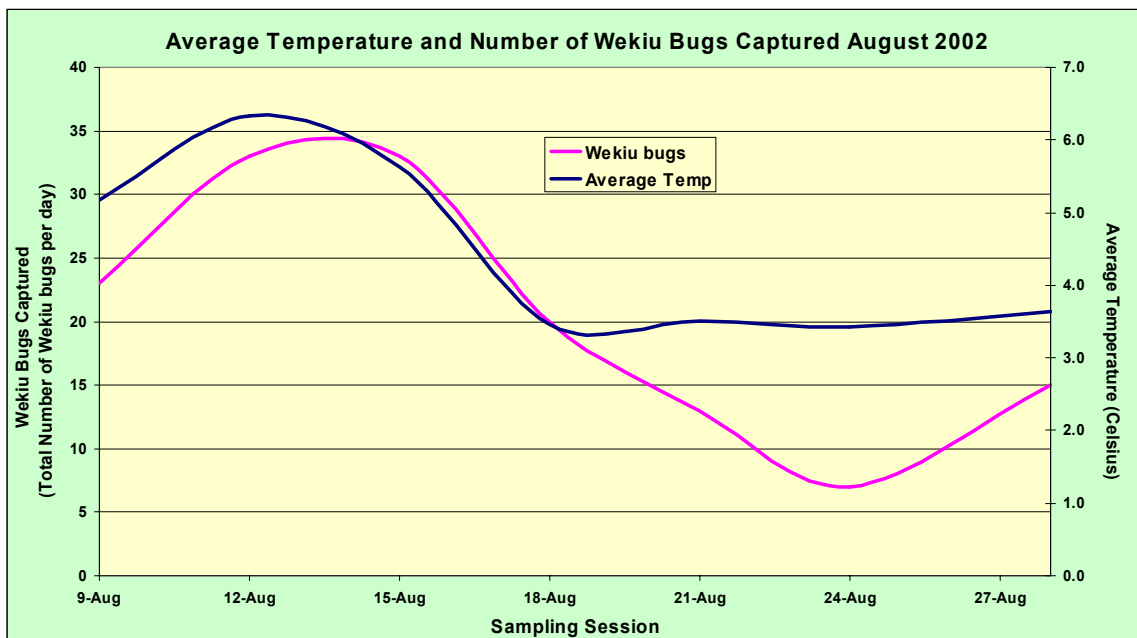


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in August 2002.

Wēkiu Bug Baseline Monitoring
RESULTS

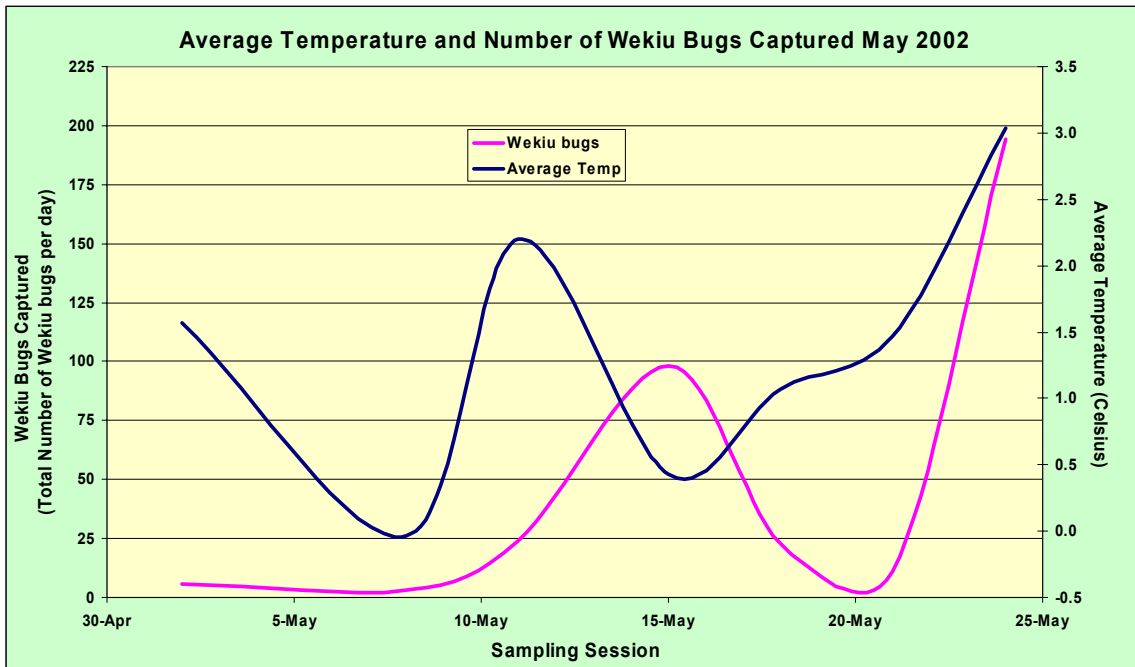


FIGURE 4. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in May 2002.

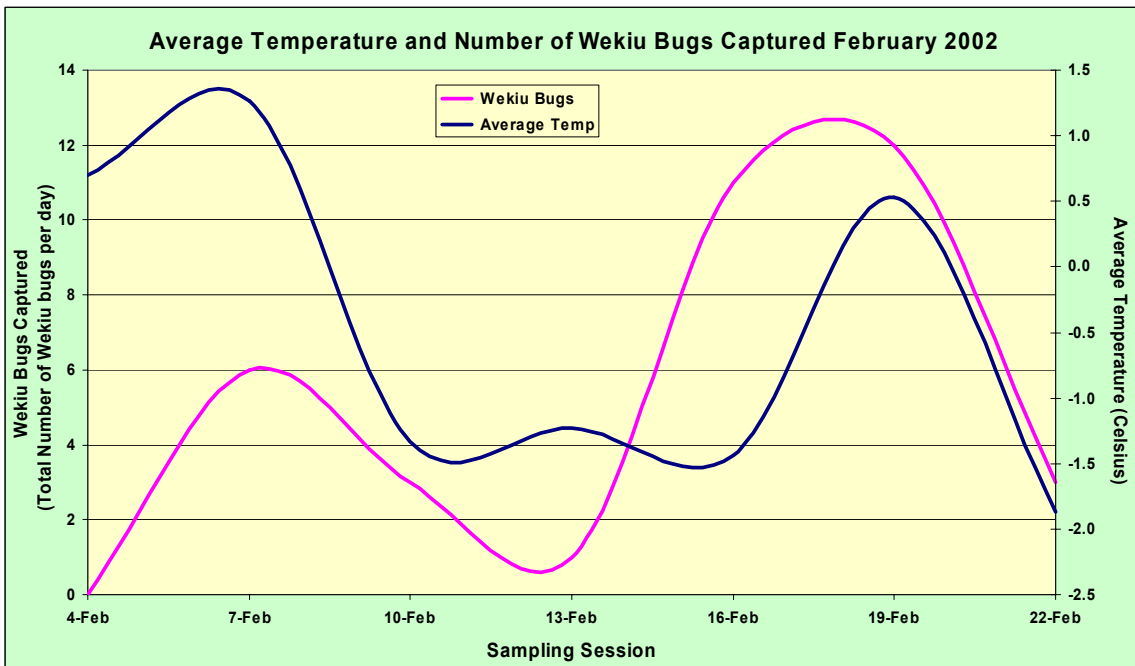


FIGURE 5. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in February 2002.

**Wēkiu Bug Baseline Monitoring
RESULTS**

Pu‘u Hau ‘Oki Inner Slope Photographic Archive

MARCH - APRIL 2003



**Pu‘u Hau ‘Oki inner slope
March 25, 2003**



**Pu‘u Hau ‘Oki inner slope
March 27, 2003**



**Pu‘u Hau ‘Oki inner slope
March 30, 2003**



**Pu‘u Hau ‘Oki inner slope
April 02, 2003**

Wēkiu Bug Baseline Monitoring RESULTS



**Pu'u Hau 'Oki inner slope
April 05, 2003**



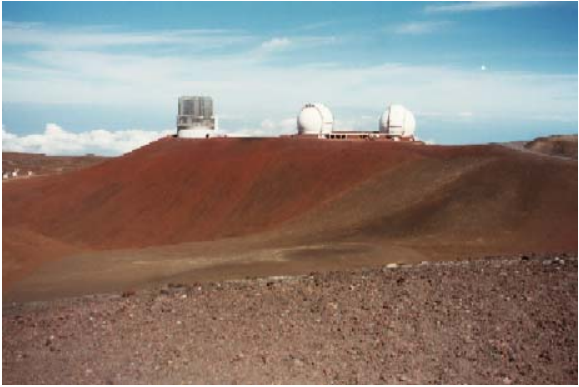
**Pu'u Hau 'Oki inner slope
April 08, 2003**



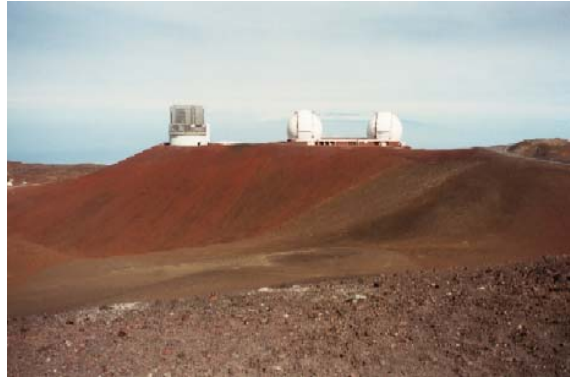
**Pu'u Hau 'Oki inner slope
April 11, 2003**

Pu’u Hau ‘Oki Outer Slope Photographic Archive

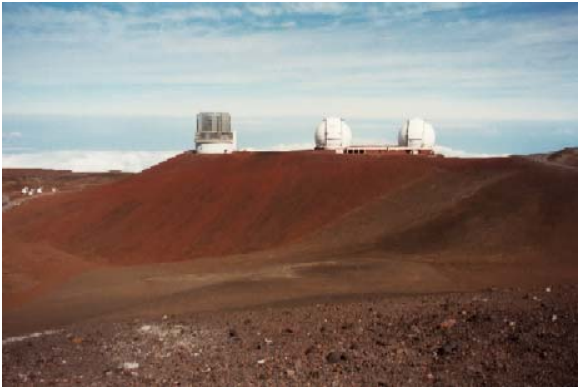
MARCH - APRIL 2003



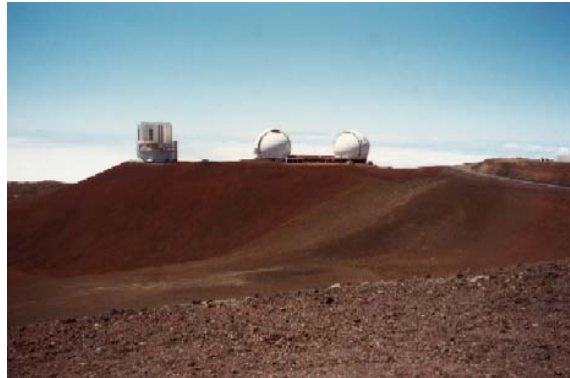
Pu’u Hau ‘Oki outer slope
March 25, 2003



Pu’u Hau ‘Oki outer slope
March 27, 2003

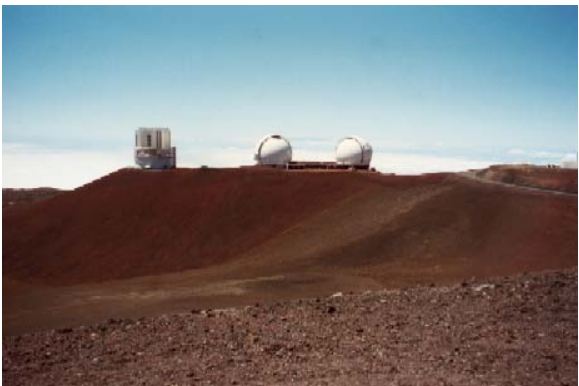


Pu’u Hau ‘Oki outer slope
March 30, 2003

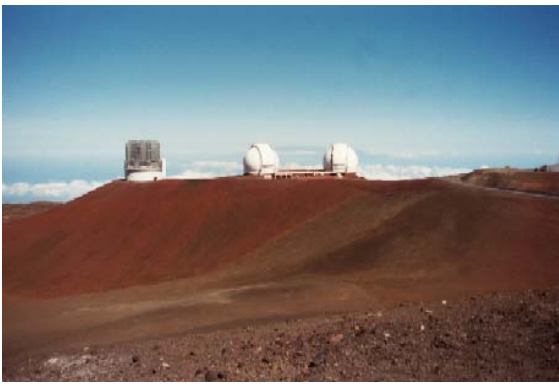


Pu’u Hau ‘Oki outer slope
April 02, 2003

Wēkiu Bug Baseline Monitoring
RESULTS



**Pu'u Hau 'Oki outer slope
April 05, 2003**



**Pu'u Hau 'Oki outer slope
April 08, 2003**



**Pu'u Hau 'Oki outer slope
April 11, 2003**

Wēkiu Bug Baseline Monitoring
RESULTS



**Pu'u Wēkiu and Hau Kea
April 05, 2003**



**Pu'u Wēkiu and Hau Kea
April 08, 2003**



**Pu'u Wēkiu and Hau Kea
April 11, 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. After a few days to allow the traps to settle in, the traps were baited and set.

Sampling began in 2002. The 2002 1st Quarter 3-week sampling session was conducted from February 1, 2002 to February 22, 2002 with samples acquired every three days (seven samples per trap). The 2002 2nd Quarter 3-week sampling session began on April 30, 2002, and sampling occurred every third day thereafter until May 24 (seven samples per trap). Traps were set for the 2002 3rd Quarter sampling session on August 6, 2002 and checked every third day beginning August 9 through August 28 (seven samples per trap). Traps were set for the 2002 4th Quarter sampling session on November 8, 2002 and checked every third day beginning November 11 through November 29 (seven samples per trap).

Sampling continued in 2003. The 2003 1st Quarter 3-week sampling session was conducted from March 22, 2003 to April 11, 2003 with samples acquired every three days (seven samples per trap).

During the 2003 1st Quarter sampling session Wēkiu bugs appeared in all ten of the traps, and a total of seven hundred and eight Wēkiu bugs appeared in or near the traps. That represents about a twenty-fold increase over trap captures in February 2002, and about twice that captured during May 2002. About eighty-six percent (608 Wēkiu bugs) of the Wēkiu bugs captured appeared in live-traps on Pu‘u Hau ‘Oki. One hundred Wēkiu bugs appeared in live-traps on Pu‘u Wēkiu. All live bugs were released back into their habitat.

During the 1997/98 Mauna Kea Science Reserve Arthropod Assessment prepared for the 2000 Mauna Kea Master Plan, a standard was established to compare trap capture rates between various studies. The standard unit of measurement is the number of Wēkiu bugs per trap per 3 days of sampling.

Wēkiu Bug Baseline Monitoring
DISCUSSION

The trap capture rate on Pu'ū Hau 'Ōki during 2003 1st Quarter Baseline Monitoring session ranged from 2.8 to 43.2 Wēkiu bugs per trap per 3-days (Table 1). The trap capture rate in 2002 1st Quarter, 2nd Quarter, 3rd Quarter, and 4th Quarter ranged from 0 to 2.4, 1.2 to 38.8, 2.6 to 6.6, and 0.6 to 12.2 Wēkiu bugs per trap per 3-days respectively. During the 1997/98 MKSR Arthropod Assessment, average trap capture rates on Pu'ū Hau 'Ōki ranged from 0 to 1.1 Wēkiu bugs (Table 3).

During the 2003 1st Quarter monitoring on Pu'ū Wēkiu the trap capture rate ranged from 0 to 6.6 Wēkiu bugs. During the 1997/98 study trap capture rates ranged from 0 to 0.15 Wēkiu bugs (Table 3).

The 2003 1st Quarter average trap capture rate was 17.54 Wēkiu bugs per trap per 3 days of sampling on Pu'ū Hau 'Ōki and 2.80 on Pu'ū Wēkiu (Table 2). During the last 3-day sampling period (April 08 - 11) there was a storm at the summit and several inches of snow accumulated. Trap capture rates during this period fell dramatically. Wēkiu bugs appeared to be less active, perhaps seeking shelter from adverse conditions rather than foraging. During the April 1998 sampling period of the 1997/98 Arthropod Assessment trap capture rates averaged 0.2 on Pu'ū Hau 'Ōki

and 0.07 on Pu'ū Wēkiu (Table 3). Trap capture rates in 2003 represented an increase of at least 40 times that measured in 1998. Apparently, Wēkiu bug populations may have increased since 1998.

The 2003 1st Quarter Wēkiu bug capture rate was about twice the capture rate measured in May 2002, the period of highest Wēkiu bug measured in 2002. It appears that Wēkiu bugs were more active in March - April 2003 than during any other period measured in 2002.

The average trap capture rate on Pu'ū Wēkiu during the 2003 1st Quarter sampling was twenty times greater than the 2002 overall average (Table 2). Because of disturbance, traps on Pu'ū Wēkiu were relocated for this sampling 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 38%. In an effort to reduce mortality, a modification was made to the trap, adjusting the coffee filter wick to reduce the amount of moisture in the trap cup. Trap mortality dropped to less than 9% in modified traps. Further testing is necessary to show that the modifications are responsible

Wēkiu Bug Baseline Monitoring
 DISCUSSION

for mortality reduction. Other factors may have contributed to the decrease, including weather conditions. Preliminary data indicate that trap capture rates are not affected by the trap improvement.

About 11% of the Wēkiu bugs captured during this sampling session were juveniles. Apparently, Wēkiu bugs are breeding. In August and November 2002, nearly 23% and 18% (respectively) of all Wēkiu bugs captured were juveniles. As more information is gathered through monitoring, a clearer picture should emerge about the 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, and Figure

5). 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 regulated by temperature.

Other Observations

No large trucks were observed at the WMKO during the 1st 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.

Wēkiu Bug Baseline Monitoring
DISCUSSION

Several signs that are posted provide safety for visitors but also help protect Wēkiu bug habitat. For example, on Pu'u Wēkiu, a sign prohibits off-road driving on Wēkiu bug habitat

Another sign, on Pu'u Hau 'Oki, asks visitors to limit speeds to prevent dust. Dust not only can damage observatory optics, but may also disturb Wēkiu bug habitat.

