# WĒKIU BUG BASELINE MONITORING

# QUARTERLY REPORT 2<sup>nd</sup> QUARTER 2003

Prepared for

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

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## Wēkiu Bug Baseline Monitoring TABLE OF CONTENTS

# WĒKIU BUG BASELINE MONITORING

# QUARTERLY REPORT 2<sup>nd</sup> QUARTER 2003

### I. TABLE OF CONTENTS

		Page
I.	TABLE OF CONTENTS	1
II.	EXECUTIVE SUMMARY	2
III.	INTRODUCTION	4
IV.	QUESTIONS OF INTEREST	6
V.	METHODS	8
VI.	RESULTS	12
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 Wekiu 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 Wekiu Bug Mitigation Plan and Wekiu Bug Monitoring Plan. They are also the participants in this Wēkiu Bug Baseline Monitoring Plan.

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

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

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

### Wēkiu Bug Baseline Monitoring EXECUTIVE SUMMARY

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

The 2003 2<sup>nd</sup> Quarter three-week sampling session was conducted from June 12, 2003 through June 30, 2003. During this sampling session a total of 3,063 Wēkiu bugs appeared in or near the live-traps. Two thousand seven hundred and seventeen were found on Pu'u Hau 'Oki, and three hundred and forty-six on Pu'u Wēkiu. Trap capture rates ranged from 2.0 to 138.8 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Pu'u Hau 'Oki during the 2<sup>nd</sup> Quarter 2003 monitoring session was 90.6 (±12.92) Wēkiu bugs per trap per 3 days of sampling. This rate is about nine times greater than the average capture rate measured on Pu'u Hau 'Oki during

the 2<sup>nd</sup> Quarter baseline monitoring session in May 2002, and is very close to the average trap capture rate of 105.6 recorded in 1982 on Pu'u Hau 'Oki.

The average trap capture rate on Pu'u Wēkiu during the 2<sup>nd</sup> Quarter 2003 monitoring session was 11.5 Wēkiu bugs per trap per 3 days of sampling. This rate is about 383 times greater average capture than the measured on Pu'u Wēkiu during the 2nd Quarter baseline monitoring session in May 2002. These rates cannot be directly compared because trap locations changed on Pu'u Wēkiu in 2003. The trap capture rate recorded in this session was about 4 times greater than that recorded during the 1st Quarter 2003 baseline monitoring session sampled identical locations.

Two thousand four hundred and seventy-seven (80%) of the Wēkiu bugs captured during the 2<sup>nd</sup> Quarter 2003 monitoring session were juveniles, an indication that the population is 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 on-site construction and installation of the Outrigger Telescopes Project. To

that end these participants have prepared the Wēkiu Bug Mitigation Plan and Wēkiu Bug Monitoring Plan. They are also the participants in this Wēkiu Bug Baseline Monitoring Plan.

Sampling of Wekiu bug habitat was establish approved to baseline population estimates of the Wekiu bug in the area surrounding the site of the proposed Outrigger Telescopes Project and at a control site on Pu'u Wēkiu. The 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 Regents. This Board of 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 INTRODUCTION

the sampling effort conducted June 12, 2003 through June 30, 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.



Immature Wēkiu bug (left) and a mating pair (center) in a trap on Pu'u Hau 'Oki near the summit of Mauna Kea.

Actual size of nymph is less than ¼ inch (~3 mm).

# 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 Wekiu bug population attributes, and characteristics,
- 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.



Lycosid spider found in Live Trap on Pu'u Wēkiu. Actual size is about 1 ½ inches (~40 mm).

### 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. 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.

# **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 previously 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.

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

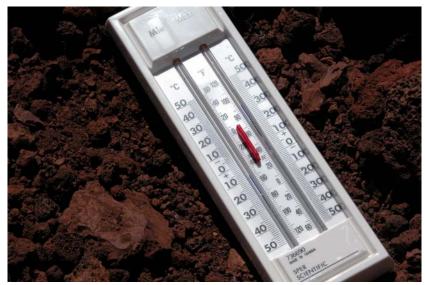
### Wēkiu Bug Baseline Monitoring METHODS

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.

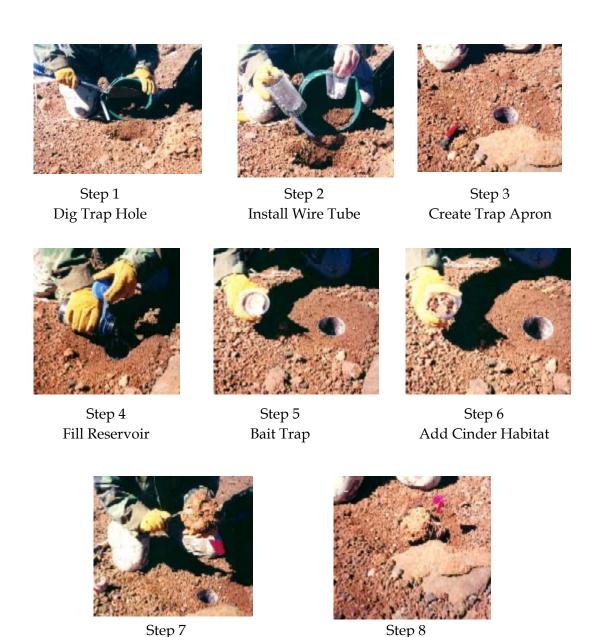
Traps were opened for the 2003 2<sup>nd</sup> Quarter baseline monitoring session on June 12, 2003. The traps were checked every three days and were closed on June 30, 2003.



Min/Max thermometer used to measure temperature under the cinder near a live-trap.

### Wēkiu Bug Baseline Monitoring METHODS

# Setting a Wēkiu Bug Live-Trap



Distribute Chum Bait

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 windchill 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

### VI. RESULTS

### SAMPLING INFORMATION

During the 2003 2nd Quarter baseline monitoring session there were a total of eighteen sampling nights, making six 3-day sampling periods. A total of three thousand and sixty-three Wēkiu bugs were captured, two thousand seven hundred and seventeen on Pu'u Hau 'Oki and three hundred and forty-six on Pu'u Wēkiu. The trap capture rate (number of Wēkiu bugs per trap per 3-days) ranged from two to 138.8 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 90.6 Wēkiu

bugs for Pu'u Hau 'Oki, and 11.5 Wēkiu bugs for Pu'u Wēkiu (Table 1). For comparison, average trap capture rates from previous baseline monitoring sessions in 2002 and the 1997/98 Arthropod Assessment are provided (Table 2, Table 3, and Table 4).

Overall mortality was about 2% (59 of 3,063). Adult mortality was 3.7% (23 of 616) and juvenile mortality was 1.5% (36 of 2,447).

# TABLE 1. 2<sup>nd</sup> QUARTER 2003 SAMPLING PERIOD AVERAGE TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each 3-day sampling period for 2<sup>nd</sup> Quarter 2003 Baseline Monitoring.

Location	06/15/03	06/18/03	06/21/03	06/24/03	06/27/03	06/30/03	AVERAGE
Pu'u Wekiu	27.8	22.8	2.0	6.4	4.6	5.6	11.5
Pu'u Hau'Oki	138.8	111.2	99.4	60.6	58.4	75.0	90.6

# 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 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

<sup>\*</sup> 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

### 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 2<sup>nd</sup> 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).

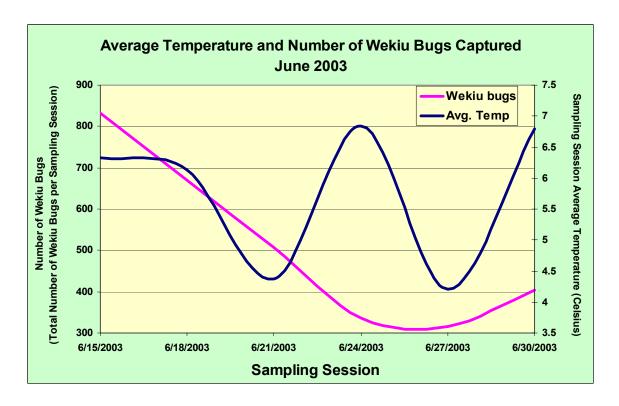


FIGURE 1. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in June 2003.

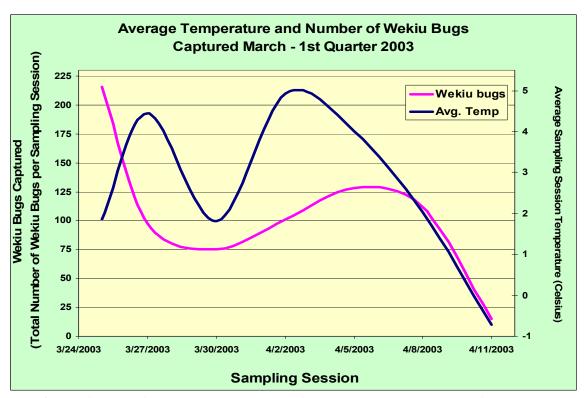


FIGURE 2. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in March – April 2003.

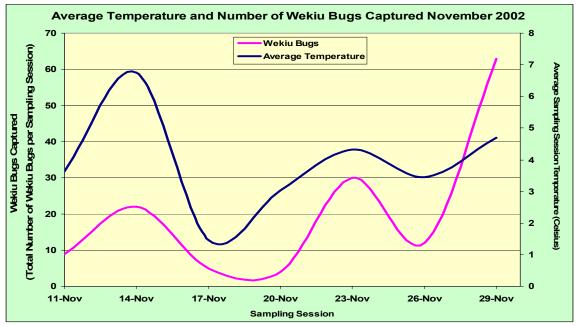


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in November 2002.

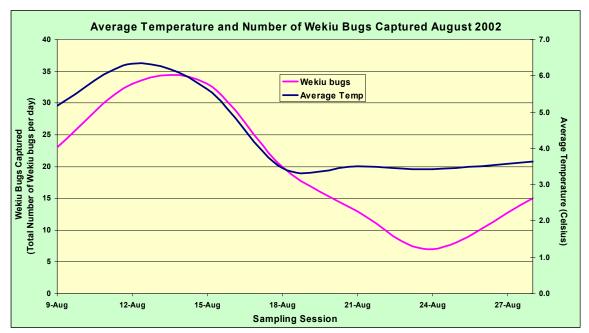


FIGURE 4. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in August 2002.

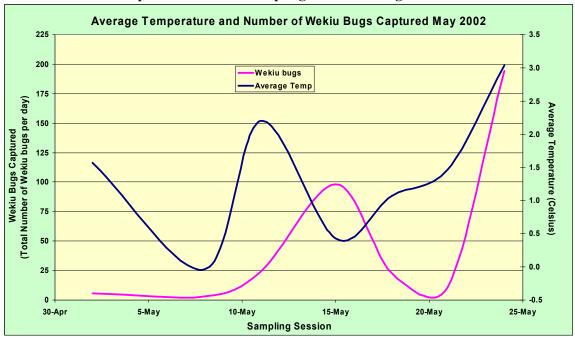


FIGURE 5. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in May 2002.

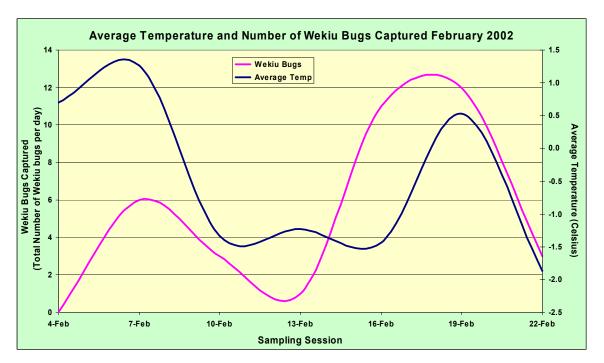


FIGURE 6. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in February 2002.

# 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



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



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



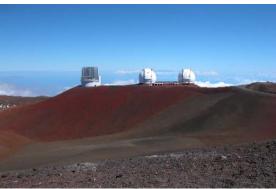
Pu'u Hau 'Oki inner slope June 30, 2003

# Pu'u Hau 'Oki Outer Slope Photographic Archive

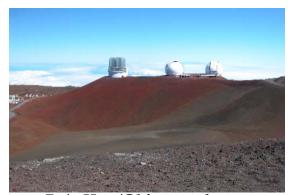
# **JUNE 2003**



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

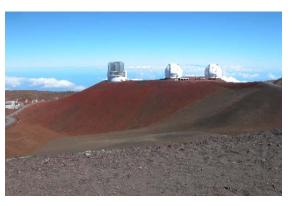


Pu'u Hau 'Oki outer slope June 21, 2003

# 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

# **JUNE 2003**



Pu'u Wēkiu inner slope June 12, 2003



Pu'u Wēkiu inner slope June 15, 2003



Pu'u Wēkiu inner slope June 18, 2003



Pu'u Wēkiu inner slope June 21, 2003



Pu'u Wēkiu inner slope June 24, 2003



Pu'u Wēkiu inner slope June 27, 2003



Pu'u Wēkiu inner slope June 30, 2003

# 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 RESULTS



Pu'u Wēkiu and Hau Kea June 24, 2003



Pu'u Wēkiu and Hau Kea June 27, 2003



Pu'u Wēkiu and Hau Kea June 30, 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 2<sup>nd</sup> 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 2<sup>nd</sup> Quarter sampling session Wēkiu bugs appeared in all ten of the traps, and a total of three thousand and sixty-three Wekiu bugs appeared in or near the traps during the six trapping sessions. About eighty-eight percent (2,717 Wēkiu bugs) of the Wekiu bugs captured appeared in live-traps on Pu'u Hau Three hundred and forty-six 'Oki. Wēkiu bugs appeared in live-traps on Pu'u Wēkiu. All live bugs were released back into their habitat.

Average 2<sup>nd</sup> Quarter 2003 trap capture rate on Pu'u Hau 'Oki was 90.6 bugs per trap per 3-day trapping period. Average 2<sup>nd</sup> 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 2<sup>nd</sup> Quarter Wēkiu bug capture rate was about nine times the capture rate measured in May 2002, the period of highest Wekiu 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  $2^{nd}$ Ouarter 2003 monitoring and 10.1 during the 2<sup>nd</sup> 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 2<sup>nd</sup> 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. modified live-traps were used exclusively during the 2<sup>nd</sup> 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 Wekiu 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 Wekiu bug activity may be somewhat regulated by temperature.



Wasp that appeared in live-trap.

### **Other Observations**

During the 2<sup>nd</sup> 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

### HABITAT PROTECTION

Recommendation IV-2: Under no circumstances should cinder or other materials be side-cast into Wēkiu bug habitat. Temporary, and if possible, permanent barriers should be built along the slope breaks above the inner slopes of Pu'u Hau 'Oki crater.

Temporary barriers were set up along the slope break to prevent materials from falling onto the slopes adjacent to the TOTS.



Temporary silt-fence type barrier designed for the Outriggers Telescope project is used to prevent side-cast cinder from disturbing Wēkiu bug habitat.

### **DUST CONTROL**

Recommendation V-1: Water should be applied to excavation sites and cinder stockpiles.



Construction worker applies potable water to cinder added to cover the TOTS foundation.

Potable water was applied to cinder before it was moved and after it was emplaced at the site.

Recommendation VII-2: Construction materials stored at the site should be covered with tarps, or anchored in place, and not be susceptible to movement by wind.



Cinder stockpiles were covered with tarps secured with cables to prevent dust from entering Wēkiu bug habitat.

Equipment as secured each night to prevent it from being blown onto Wēkiu bug habitat. Cinder stockpiles

### 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.