

WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT 4th QUARTER 2003

Prepared for

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

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QUARTERLY REPORT
4th 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
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 4th Quarter 2003 three-week sampling session was conducted from November 28, 2003 through December 19, 2003. During this sampling session a total of 29 Wēkiu bugs appeared in or near the live-traps. All were found on Pu'u Hau 'Oki. Trap capture rates ranged from zero to 5.6 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Pu'u Hau 'Oki during the 4th Quarter 2003 monitoring session was 0.83 Wēkiu bugs per trap per 3 days of sampling. This rate is about one fourth the average capture rate measured on

Pu'u Hau 'Oki during the 4th Quarter 2002 baseline monitoring session. Weather may have played a role in reducing the Wēkiu bug trap capture rate because snow and severe weather occurred throughout the 4th Quarter 2003 sampling session.

The average trap capture rate on Pu'u Wēkiu during the 4th Quarter 2003 monitoring session was 0.00 Wēkiu bugs per trap per 3 days of sampling. This rate is biologically equivalent to the average capture rate measured on Pu'u Wēkiu during the 4th Quarter 2002 baseline monitoring session (0.17 Wēkiu bugs per trap per 3 days of sampling). These rates cannot be directly compared because trap locations changed on Pu'u Wēkiu in 2003.

None of the Wēkiu bugs captured during the 4th Quarter 2003 monitoring session were juveniles. Evidently juveniles are not active during the winter months or during severe weather conditions.


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 eight Quarterly Report of Baseline Monitoring. The results of

Wēkiu Bug Baseline Monitoring
INTRODUCTION

the sampling effort conducted November 28, 2003 through December 19, 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.



Lenticular clouds near the summit of Mauna Kea on November 28, 2003.

Wēkiu Bug Baseline Monitoring
QUESTIONS OF INTEREST

IV. QUESTIONS OF INTEREST

Important Questions of Interest are those with answers that can be efficiently estimated and that yield the information necessary for management decision-making. The following Questions of Interest were developed in the Baseline Monitoring Plan and are the focus of this report.

Question 1

How, where and when are the Wēkiu bug populations changing? Locations of interest include current habitat on Pu'u Hau 'Oki crater and undisturbed Wēkiu bug habitat at Pu'u Wēkiu (for comparison).

Justification:

Baseline monitoring of Wēkiu bugs will yield reliable scientific information about the current status of Wēkiu bugs, and trends in their population. The information will be useful to compare to status and trends during construction of the proposed Outrigger Telescopes.

Monitoring goals:

- 1) To provide historical records of change in Wēkiu bug population attributes, and characteristics,
- 2) To detect trends, periodicities, cycles, and/or other patterns in those changes, and
- 3) To associate auxiliary phenomena, attributes, and characteristics with trends and patterns of change in Wēkiu bug population attributes, and characteristics.

Wēkiu Bug Baseline Monitoring
QUESTIONS OF INTEREST

Question 2

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

Justification:

Snow, rain, day/night temperatures, and other weather phenomena may be associated with Wēkiu Bug population change. Monitoring these indirect factors will aid in understanding trends in Wēkiu Bug population change.

Monitoring goals:

To associate environmental phenomena and attributes, and characteristics of human activities with trends and patterns of change in Wēkiu Bug populations.



Noctuid moth larva found in Live Trap on Pu‘u Wēkiu.
Actual size is about 1 inches (~23 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. 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.

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 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**

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 4th Quarter baseline monitoring session on November 28, 2003. The traps were checked every three days and were closed on December 19, 2003. During some of the sampling sessions traps were found filled with ice.



Frozen Live-trap flooded with water during the December 1-4 sampling session.

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



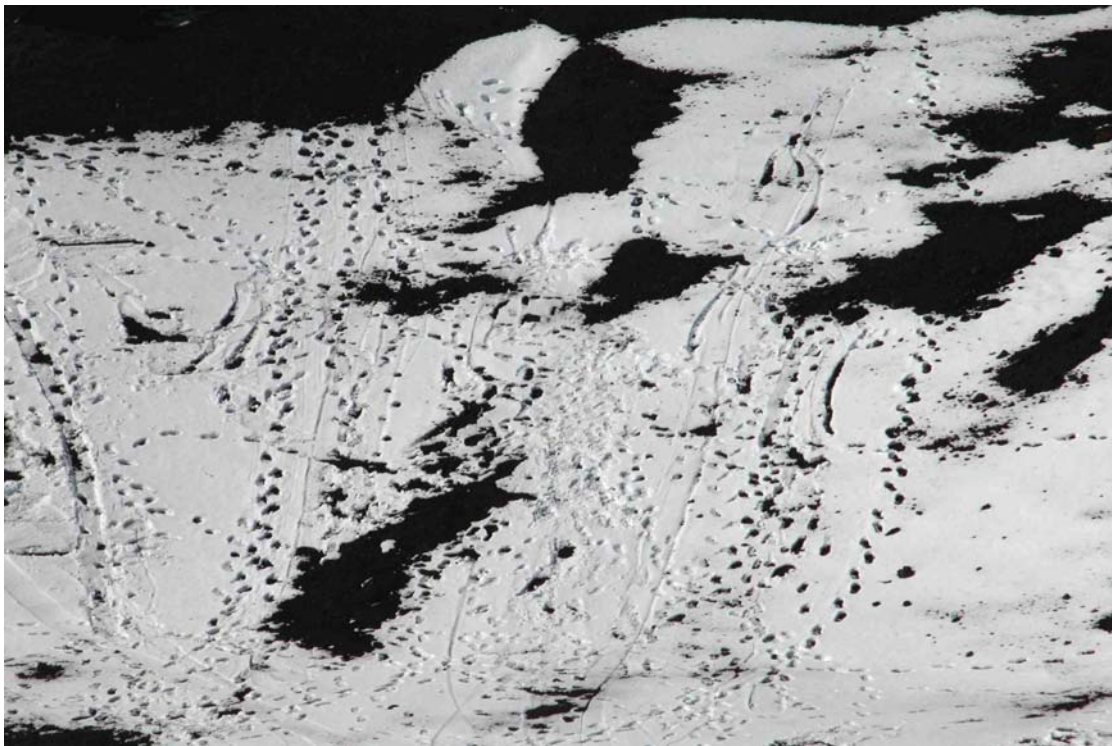
Step 8
Emplace Cap Rock

Wēkiu Bug Baseline Monitoring
METHODS


Weather Data

Daily weather data from the UKIRT Observatory on the summit of Mauna Kea is usually downloaded from the Internet/World Wide Web at <http://hokukea.soest.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.

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.




Tracks made in snow in Pu'u Hau 'Oki crater. Photo taken on December 4, 2003.



Wēkiu Bug Baseline Monitoring

RESULTS



VI. RESULTS

SAMPLING INFORMATION

During the 2003 4th Quarter baseline monitoring session there were a total of twenty-one sampling nights, making seven 3-day sampling periods.

A total of twenty-nine Wēkiu bugs were captured, all on Pu'u Hau 'Oki. The trap capture rate (number of Wēkiu bugs per trap per 3-days) ranged from zero to 5.6 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 0.83 Wēkiu bugs for Pu'u Hau 'Oki, and 0.00 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 and Table 3).

Overall mortality was 0 (all 29 Wēkiu bugs captured were alive when released). The new live-traps appear to be successful at reducing mortality, even during rain and snow events.

TABLE 1.
4th 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 4th Quarter 2003 Baseline Monitoring.

Location	12/01/2003	12/04/2003	12/07/2003	12/10/2003	12/13/2003	12/16/2003	12/19/2003	AVERAGE
Pu'u Wēkiu	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.00
Pu'u Hau'Oki	0.0	0.0	0.0	0.0	0.2	0.0	5.6	0.83

**Wēkiu Bug Baseline Monitoring
RESULTS**

**TABLE 2.
QUARTERLY BASELINE MONITORING
AVERAGE TRAP CAPTURE RATES**

The average number of Wēkiu bugs per trap per 3-days
for each of the Quarterly Baseline Monitoring Sampling Sessions.
Yearly average trap capture rates for Baseline Monitoring are in **RED**.

Location	1 st Quarter	2 nd Quarter	3 rd Quarter	4 th Quarter	Year Avg.
Pu'u Wēkiu 2002	0.03	0.03	0.26	0.17	0.12
Pu'u Wēkiu 2003*	2.87	11.5	0.51	0.00	3.73
Pu'u Hau'Oki 2002	0.99	9.56	4.01	3.97	4.63
Pu'u Hau'Oki 2003	18.29	90.6	12.37	0.83	30.51

* 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 Wēkiu	0.15	0.0	0.07	0.15	0.11
Pu'u Hau'Oki	0.20	0.0	0.20	1.10	0.38

**Wēkiu Bug Baseline Monitoring
RESULTS**

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 4th Quarter 2003 sampling session the number of Wēkiu bugs varies 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, Figure 6, Figure 7, and Figure 8).

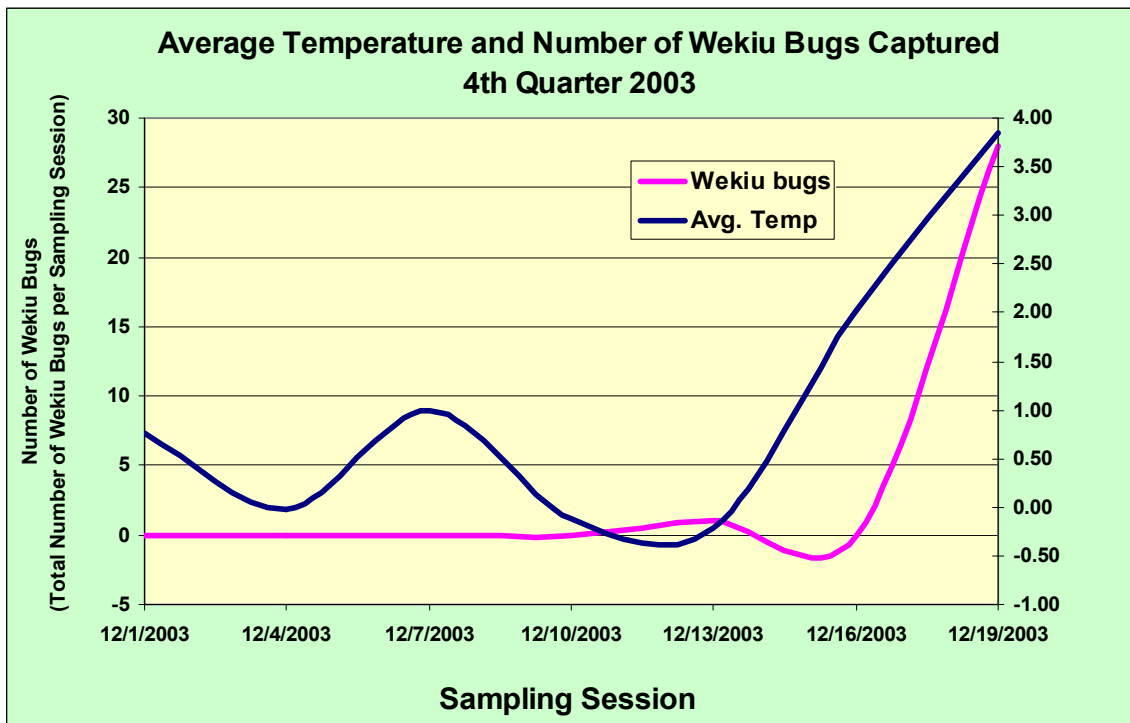


FIGURE 1. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in the 4th Quarter 2003 sampling session.

**Wēkiu Bug Baseline Monitoring
RESULTS**

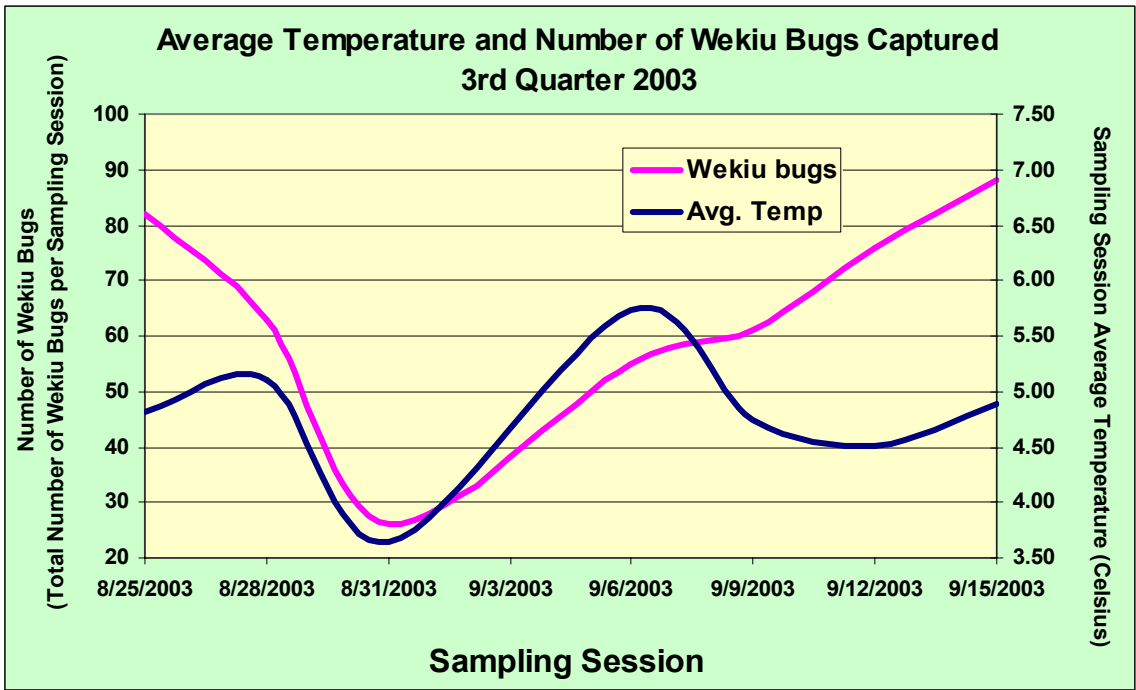


FIGURE 2. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in the 3rd Quarter 2003 sampling session.

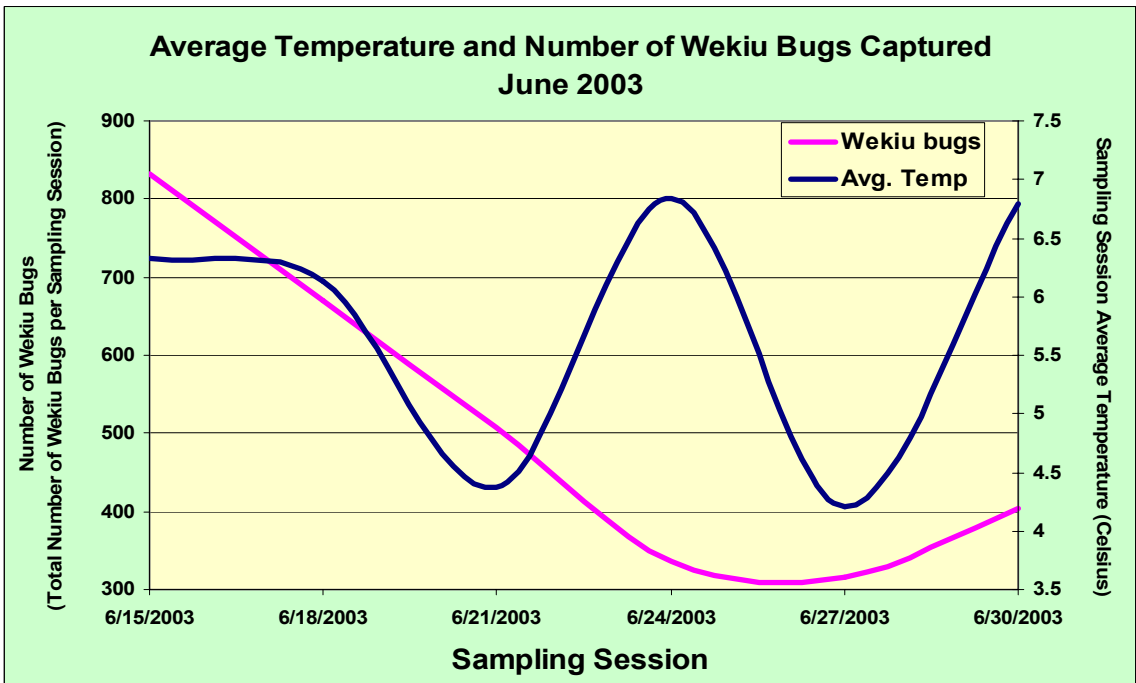


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in the 2nd Quarter 2003 sampling session.

**Wēkiu Bug Baseline Monitoring
RESULTS**

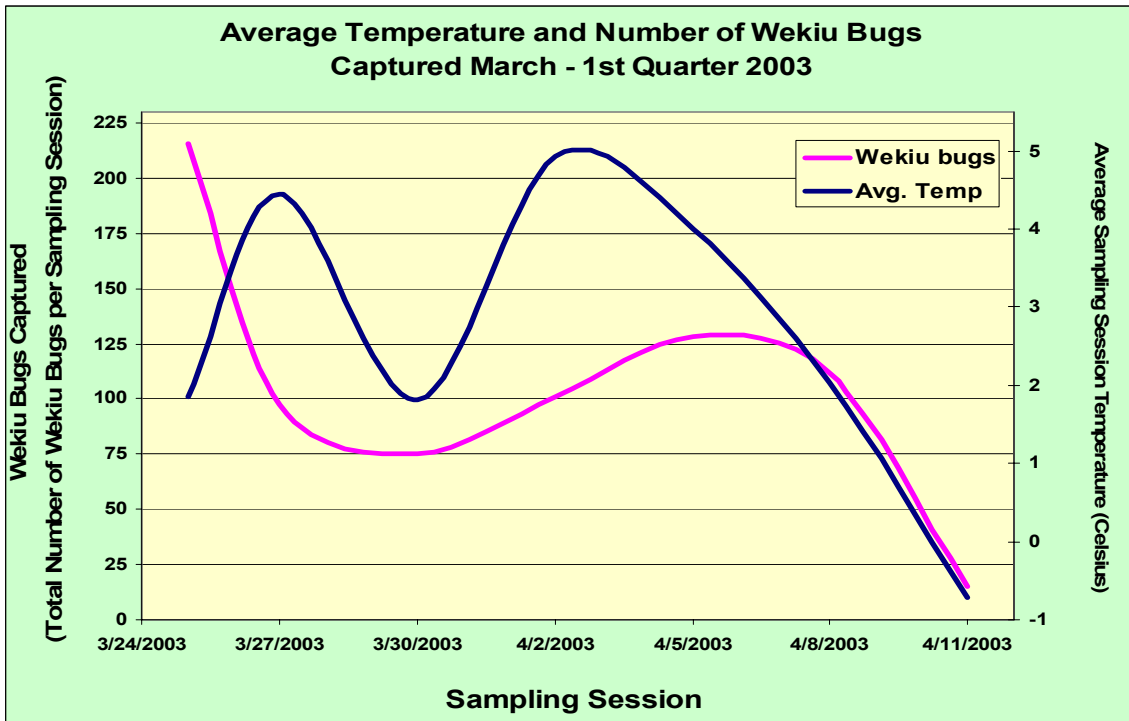


FIGURE 4. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in the 1st Quarter 2003 sampling session.

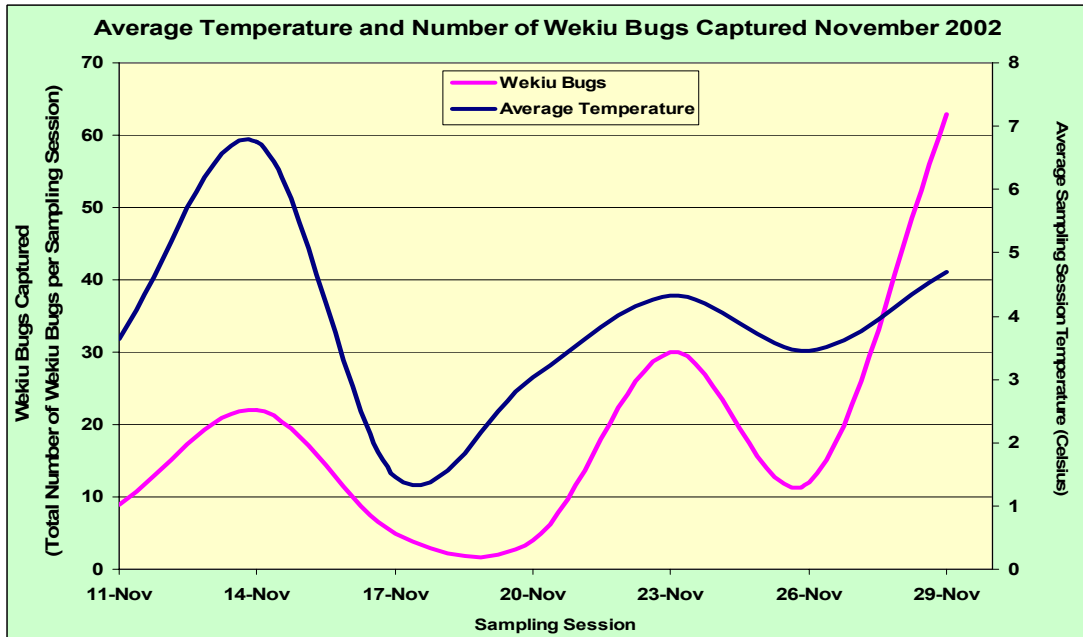


FIGURE 5. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in the 4th Quarter 2002 sampling session.

**Wēkiu Bug Baseline Monitoring
RESULTS**

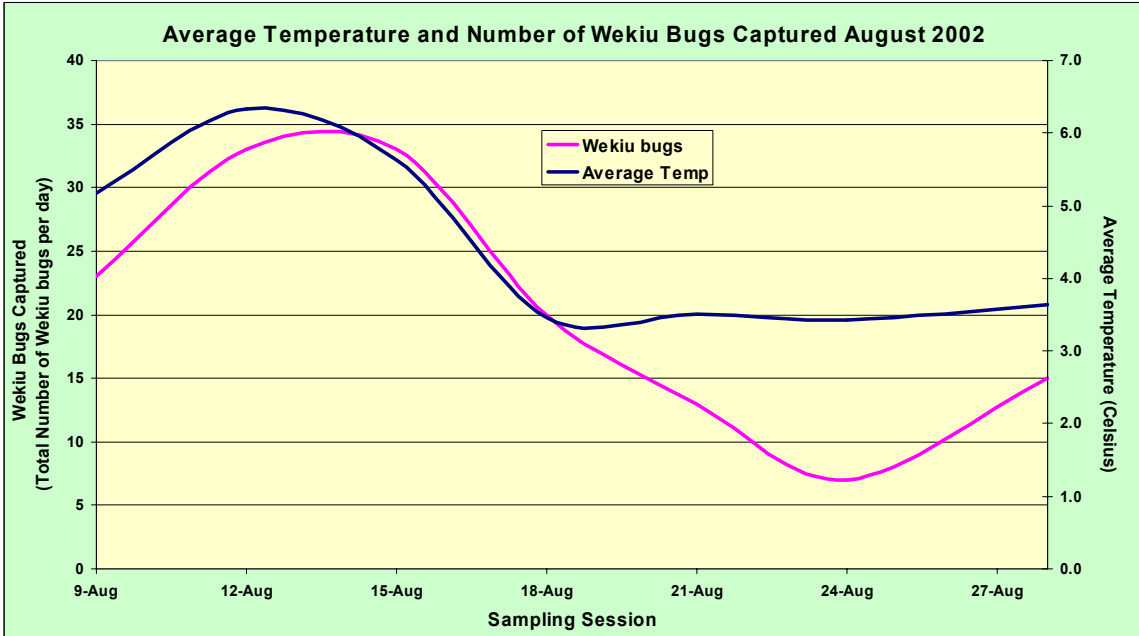


FIGURE 6. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in 3rd Quarter 2002 sampling session.

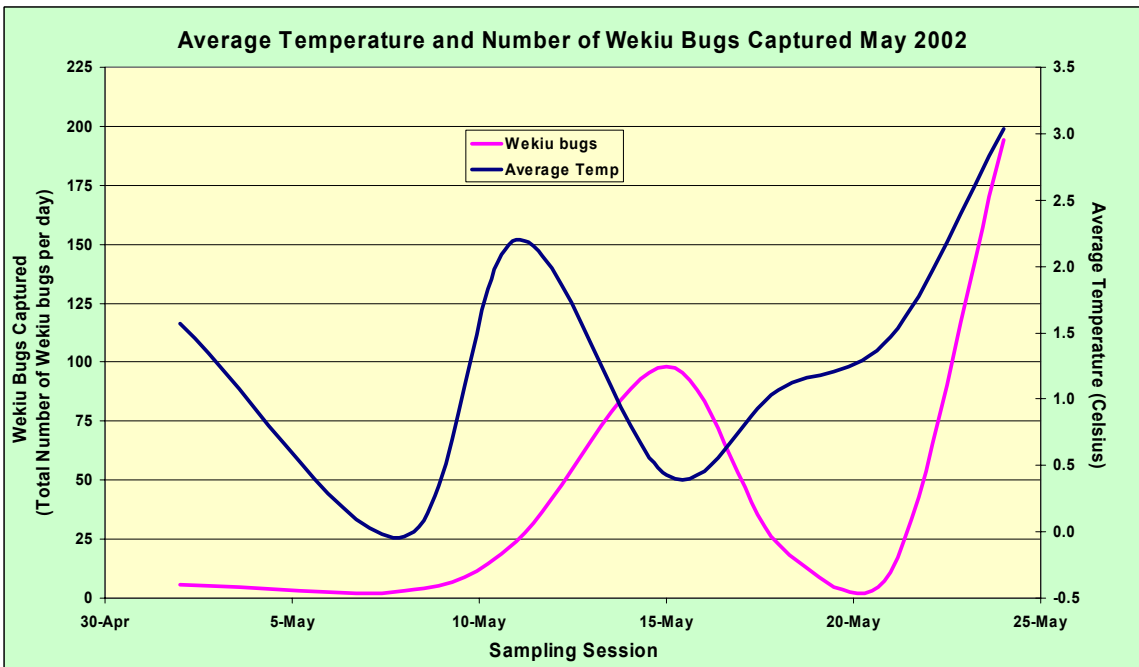


FIGURE 7. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in the 2nd Quarter 2002 sampling session.

**Wēkiu Bug Baseline Monitoring
RESULTS**

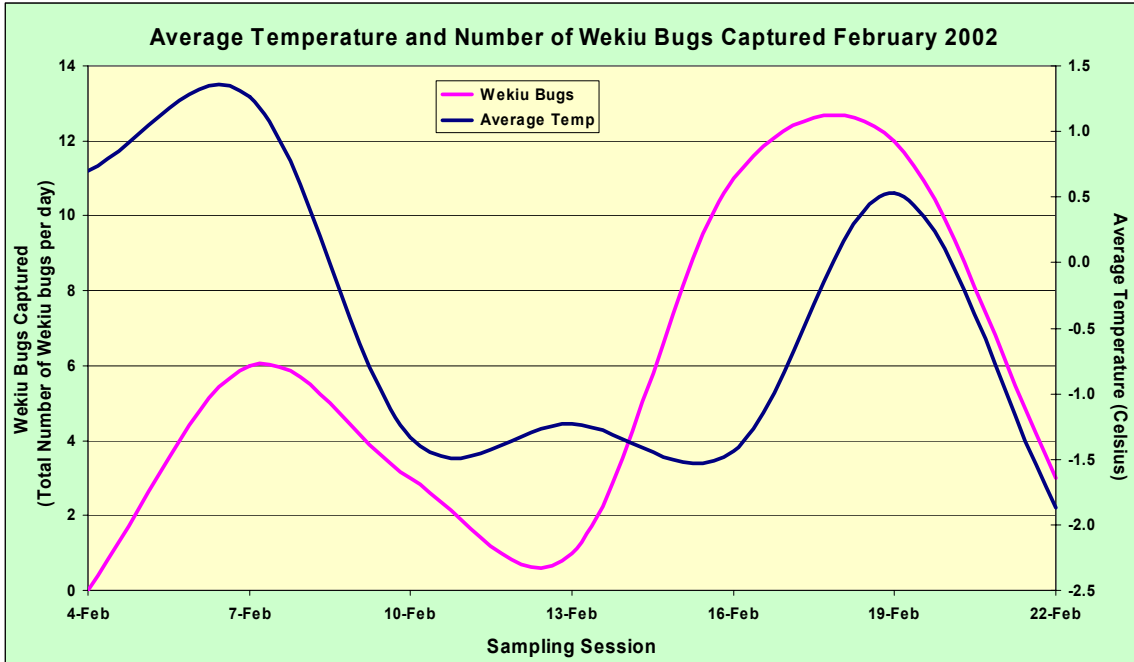


FIGURE 8. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in the 1st Quarter 2002 sampling session.

Wēkiu Bug Baseline Monitoring
RESULTS

Pu'u Hau 'Oki Inner Slope Photographic Archive

NOVEMBER - DECEMBER 2003



Pu'u Hau 'Oki inner slope
November 28, 2003



Pu'u Hau 'Oki inner slope
December 01, 2003



Pu'u Hau 'Oki inner slope
December 04, 2003



Pu'u Hau 'Oki inner slope
December 07, 2003

**Wēkiu Bug Baseline Monitoring
RESULTS**



**Pu'u Hau 'Oki inner slope
December 10, 2003**



**Pu'u Hau 'Oki inner slope
December 13, 2003**



**Pu'u Hau 'Oki inner slope
December 16, 2003**

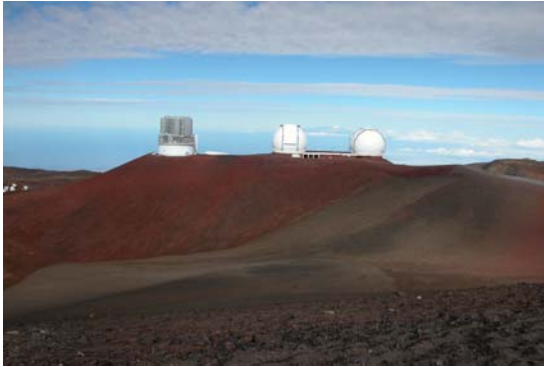


**Pu'u Hau 'Oki inner slope
December 19, 2003**

Wēkiu Bug Baseline Monitoring
RESULTS

Pu'u Hau 'Oki Outer Slope Photographic Archive

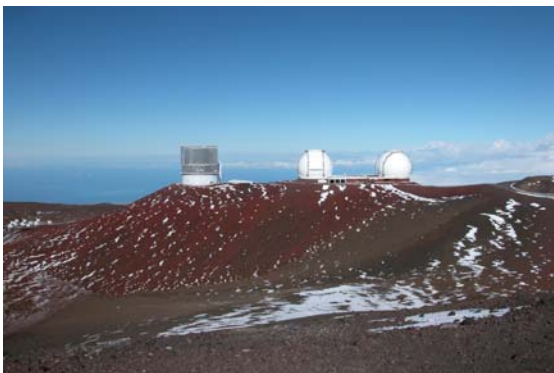
NOVEMBER - DECEMBER 2003



Pu'u Hau 'Oki outer slope
November 28 2003



Pu'u Hau 'Oki outer slope
December 01, 2003



Pu'u Hau 'Oki outer slope
December 04, 2003



Pu'u Hau 'Oki outer slope
December 07, 2003

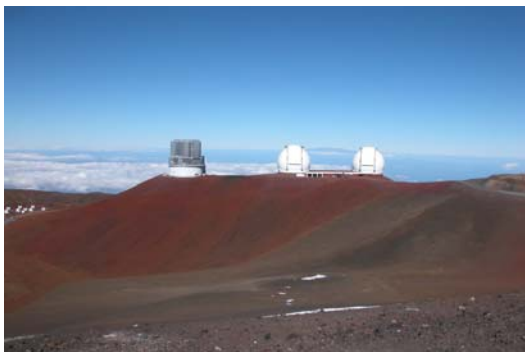
**Wēkiu Bug Baseline Monitoring
RESULTS**



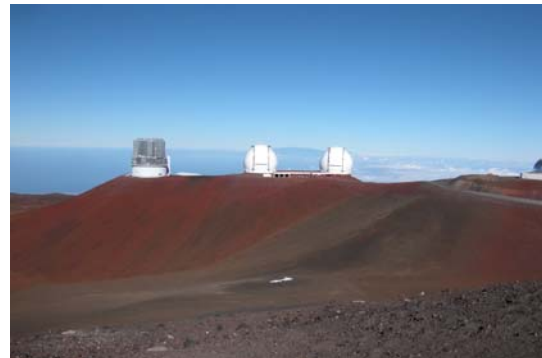
**Pu'u Hau 'Oki outer slope
December 10, 2003**



**Pu'u Hau 'Oki outer slope
December 13, 2003**



**Pu'u Hau 'Oki outer slope
December 16, 2003**



**Pu'u Hau 'Oki outer slope
December 19, 2003**

**Wēkiu Bug Baseline Monitoring
RESULTS**

Pu'u Wēkiu Photographic Archive

NOVEMBER - DECEMBER 2003



**Pu'u Wēkiu inner slope
November 28, 2003**



**Pu'u Wēkiu inner slope
December 01, 2003**

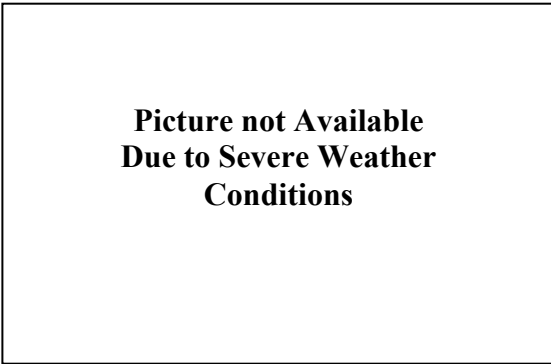


**Pu'u Wēkiu inner slope
December 04, 2003**



**Pu'u Wēkiu inner slope
December 07, 2003**

**Wēkiu Bug Baseline Monitoring
RESULTS**



**Pu'u Wēkiu inner slope
December 10, 2003**



**Pu'u Wēkiu inner slope
December 13, 2003**



**Pu'u Wēkiu inner slope
December 16, 2003**



**Pu'u Wēkiu inner slope
December 19, 2003**

**Wēkiu Bug Baseline Monitoring
RESULTS**

Pu'u Wēkiu and Hau Kea Photographic Archive

NOVEMBER - DECEMBER 2003



**Pu'u Wēkiu and Hau Kea
November 28, 2003**



**Pu'u Wēkiu and Hau Kea
December 01, 2003**



**Pu'u Wēkiu and Hau Kea
December 04, 2003**



**Pu'u Wēkiu and Hau Kea
December 07, 2003**

**Wēkiu Bug Baseline Monitoring
RESULTS**



**Pu'u Wēkiu and Hau Kea
December 10, 2003**



**Pu'u Wēkiu and Hau Kea
December 13, 2003**



**Pu'u Wēkiu and Hau Kea
December 16, 2003**



**Pu'u Wēkiu and Hau Kea
December 19, 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, 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 4.63 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 1st Quarter 2003 sampling session a total of seven hundred and twelve Wēkiu bugs appeared in or near the traps. The 1st Quarter 2003 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).

During the 2003 2nd Quarter sampling session a total of three thousand and sixty-three Wēkiu bugs appeared in or near the traps during the six trapping sessions. Average 2nd Quarter 2003 trap capture rate was 90.6 bugs per trap per 3-day trapping period on Pu‘u Hau ‘Oki and 11.5 bugs per trap per 3-day trapping period on Pu‘u Wēkiu (Table 2).

During the 2003 3rd Quarter sampling session a total of four hundred and fifty-one Wēkiu bugs appeared in or near the traps during the seven trapping sessions. Average 3rd Quarter 2003 trap capture rate was 12.4 bugs per trap per 3-day trapping period on Pu‘u Hau ‘Oki and 0.51 bugs per trap per 3-day trapping period on Pu‘u Wēkiu (Table 2).

During the 2003 4th Quarter sampling session Wēkiu bugs appeared in all five of the traps on Pu‘u Hau ‘Oki but

**Wēkiu Bug Baseline Monitoring
DISCUSSION**

none appeared in traps on Pu'u Wēkiu. A total of twenty-nine Wēkiu bugs appeared in or near the traps during the seven trapping sessions. All live bugs were released back into their habitat.

Average 4th Quarter 2003 trap capture rate on Pu'u Hau 'Oki was 0.83 bugs per trap per 3-day trapping period. Average 4th Quarter 2003 trap capture rate on Pu'u Wēkiu was 0.00 bugs per trap per 3-day trapping period. During the January 1997 sampling period of the 1997/98 Arthropod Assessment trap capture rates averaged 0.00 on Pu'u Hau 'Oki and 0.00 on Pu'u Wēkiu (Table 3).

The 4th Quarter 2003 Wēkiu bug capture rate was about one fourth the capture rate measured in the 4th Quarter 2002 sampling session. The average trap-capture rate for 2003 is 17.14 bugs per trap per 3-day trapping period. That is almost 7 times greater than the rate measured in 2002 (2.48 bugs per trap per 3-day trapping period).

No immature Wēkiu bugs were captured in the 4th Quarter 2003 sampling session. Immature Wēkiu bugs are apparently not active during the cold winter months. They were most active during June and July (the time of highest proportion of immatures).

All Wēkiu bugs survived in live-traps to be released. 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%. Mortality remained low in the modified traps during the 3rd Quarter 2003 sampling session (less than 2%). The modified live-traps are apparently successful at reducing trap mortality and should be considered for all Wēkiu bug sampling.



**Lycosid spider captured in Live-traps on
Pu'u Wēkiu on December 07, 2003 .**

**Wēkiu Bug Baseline Monitoring
DISCUSSION**

Other Observations

During the 4th Quarter 2003 monitoring session the WMKO site was free of loose trash and debris. Observatory vehicles parked near the WMKO were clean and had a small amount of mud from the summit roads. No vehicles had any visible signs of alien arthropods.



**Summit visitors shoveling snow into their pickup near Pu'u Hau 'Oki.
Picture taken on December 04, 2003.**



**Summit visitor taking pictures while standing in Wēkiu bug habitat on Pu'u Wēkiu.
Picture taken on December 04, 2003.**

During the 4th Quarter 2003 sampling session snow fell on the summit area. As usual, this brought out many visitors for snow play. On several occasions people were observed shoveling snow into the back of pickups. People were also observed walking on snow-covered slopes, building snow forts and having snowball fights.