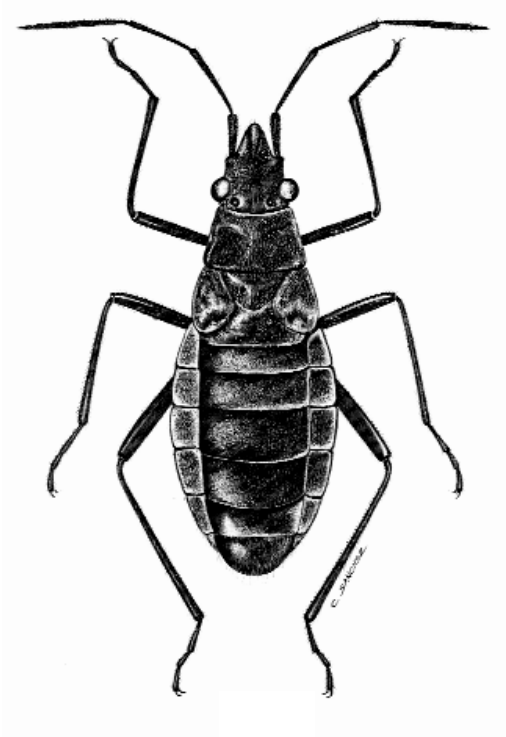
WĒKIU BUG BASELINE MONITORING

4TH QUARTER 2002 QUARTERLY REPORT



Revised April 2004

Pacific Analytics, L.L.C.

Cover : Wēkiu Bug drawn by Mr. C. Sanchez of the University of the Philippines College of Science and Humanities.

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4TH QUARTER 2002 QUARTERLY REPORT

Prepared for

The Outrigger Telescopes Project
WM Keck Observatory
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Revised April 2004

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WĒKIU BUG BASELINE MONITORING

4TH QUARTER 2002
QUARTERLY REPORT

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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 encompasses an estimated 300 acres (121 hectares) of the summit of Mauna Kea. Populations of Wēkiu bugs also occur on other cinder cones near the summit.

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 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?

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 first quarter three-week sampling session was conducted from February 1, 2002 through February 22, 2002. All live bugs were released back into their habitat. The trap capture rate during this Baseline Monitoring session ranged from 0 to 2.4 Wēkiu bugs per trap per 3 days of sampling. Thirty-four of the thirty-five Wēkiu bugs captured appeared in live-traps on Pu'u Hau 'Oki. The average trap capture rate on Pu'u Hau 'Oki was 0.99 Wēkiu bugs per trap per 3 days of sampling.

The second quarter three-week sampling session was conducted from April 29, 2002 through May 24, 2002. All of the 359 Wēkiu bugs appeared in or near traps on Pu'u Hau 'Oki. The capture rate during the second quarter session ranged from 0 to 38.8 Wēkiu bugs per trap per 3 days of sampling. The average trap capture rate on Pu'u Hau 'Oki in May 2002 was 9.56 Wēkiu bugs per trap per 3 days of sampling.

The third quarter three-week sampling session was conducted from August 6, 2002 through August 28, 2002. During that time a total of 154 Wēkiu bugs appeared in or near the live-traps. One hundred and forty-four were found on Pu'u Hau 'Oki, and ten on Pu'u Wēkiu. Trap capture rates ranged from 0.0 to 6.6 Wēkiu bugs per trap per 3 days of sampling. The average trap capture rate on Pu'u Hau 'Oki in August 2002 was 4.01 Wēkiu bugs per trap per 3 days of sampling.

The fourth quarter three-week sampling session was conducted from November 8, 2002 through November 29, 2002. During that time a total of 145 Wēkiu bugs appeared in or near the live-traps. One hundred and thirty-nine were found on Pu'u Hau 'Oki, and six on Pu'u Wēkiu. Trap capture rates ranged from 0.0 to 12.2 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Pu'u Hau 'Oki during the fourth quarter 2002 monitoring session was 3.97 (±1.55) Wēkiu bugs per trap per 3 days of sampling. This rate is about four times greater than the average capture rate measured on Pu'u Hau 'Oki during the first quarter baseline monitoring session in February 2002, about forty percent of the rate measured during the second quarter

baseline monitoring session in May 2002, and about the same as the rate measured during the third quarter baseline monitoring session in August 2002.

Twenty-six of the Wēkiu bugs captured during August were juveniles, an indication that the population is breeding.

Photo by Jeffrey C. Miller

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

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 bugs generally occupy habitat encompassing an estimated 300 acres (121 hectares) of the summit of Mauna Kea. Populations of Wēkiu bugs also occur on other cinder cones near the summit.

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 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 conducted as part of the Environmental Impact Statement prepared for the Mauna Kea 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.

INTRODUCTION

This is the fourth Quarterly Report of Baseline Monitoring. The results of the sampling effort conducted November 8 through November 29 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 bugs found on Pu‘u Hau ‘Oki near the summit of Mauna Kea. Actual size is less than ¼ inch (~3 mm).

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

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

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

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 at the same locations where traps were installed during the previous sampling sessions, five on Pu'u Hau Oki and five on Pu'u Wēkiu.

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 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 fourth baseline monitoring session on November 8, 2002. The traps were checked every three days and were closed on November 29, 2002.

OMKM Rangers patrol the MKSR, offering assistance to visitors. Protective clothing and eyewear are necessary at the summit because of intense ultraviolet radiation.

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

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.

Pu'u Kea Observatories. A view of Pu'u Kea from Pu'u Hau 'Oki. UKIRT Observatory, where weather data were collected, is the last building on the right. IRTF Observatory on Pu'u Hau 'Oki is in the foreground on the left. Photo taken February 2002.

VI. RESULTS

SAMPLING INFORMATION

During the fourth quarter baseline monitoring session there were a total of twenty-one sampling nights, making seven 3-day sampling periods. A total of one hundred and forty-five Wēkiu bugs were captured, one hundred and thirty-nine on Puʻu Hau ʻOki and six on Puʻu Wēkiu. The trap capture rate (number of Wēkiu bugs per trap per 3-days) ranged from zero to 12.2 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 3.97 Wēkiu bugs for Puʻu Hau ʻOki, and 0.17 Wēkiu bugs for Puʻu 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).

TABLE 1.
NOVEMBER SAMPLING PERIOD AVERAGE TRAP CAPTURE RATES
The average number of Wēkiu bugs per trap per 3-days for each 3-day sampling period for November 2002 Baseline Monitoring.

Location	11/11/02	11/14/2002	11/17/2002	11/20/2002	11/23/2002	11/26/2002	11/29/2002
Pu'u Wekiu	0.0	0.0	0.4	0.2	0.2	0.0	0.4
Pu'u Hau Oki	1.8	4.4	0.6	0.6	5.8	2.4	12.2

TABLE 2.
2002 BASELINE MONITORING
AVERAGE QUARTERLY TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each of the 2002 Quarterly Baseline Monitoring Sampling Sessions. Average trap capture rates for the 2002 Baseline Monitoring are in RED.

Location	Feb. 2002	May 2002	Aug. 2002	Nov. 2002	Avg. 2002
Pu'u Wekiu	0.03	0.03	0.26	0.17	**0.12 (±0.06)**
Pu'u Hau Oki	0.99	9.56	4.01	3.97	**4.63 (±1.79)**

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 on Pu'u Hau 'Oki were plotted with average temperature during the 3-day sampling periods. The pattern reveals that during the November sampling session the number of Wēkiu bugs is correlated with average temperature.

As average temperature increases, the number of Wēkiu bugs captured also increases (Figure 1). This is the same general pattern found during the August, February and May Baseline Monitoring sampling sessions (Figure 2, Figure 3, and Figure 4).

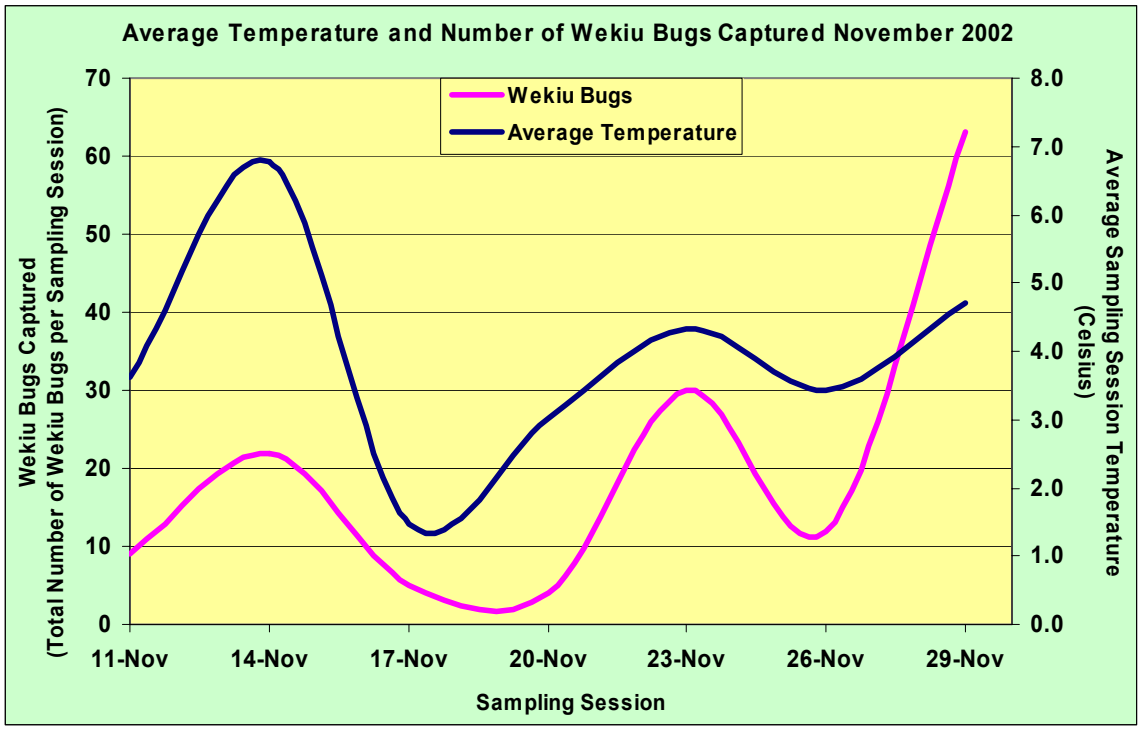


FIGURE 1. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in 4th Quarter 2002.

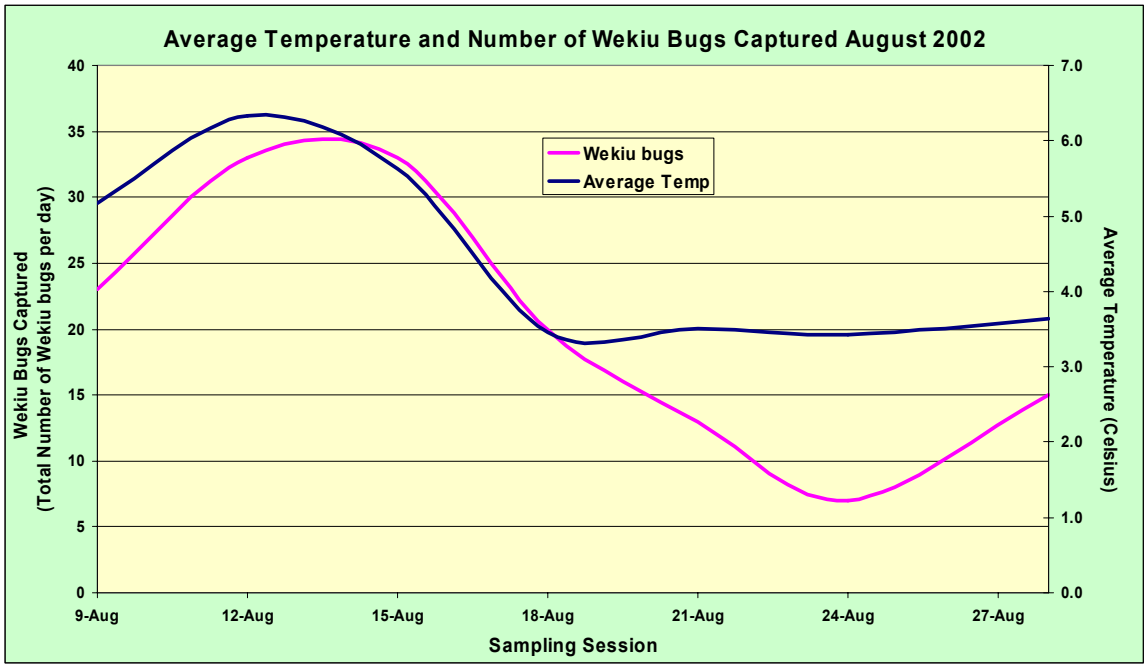


FIGURE 2. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in 3rd Quarter 2002.

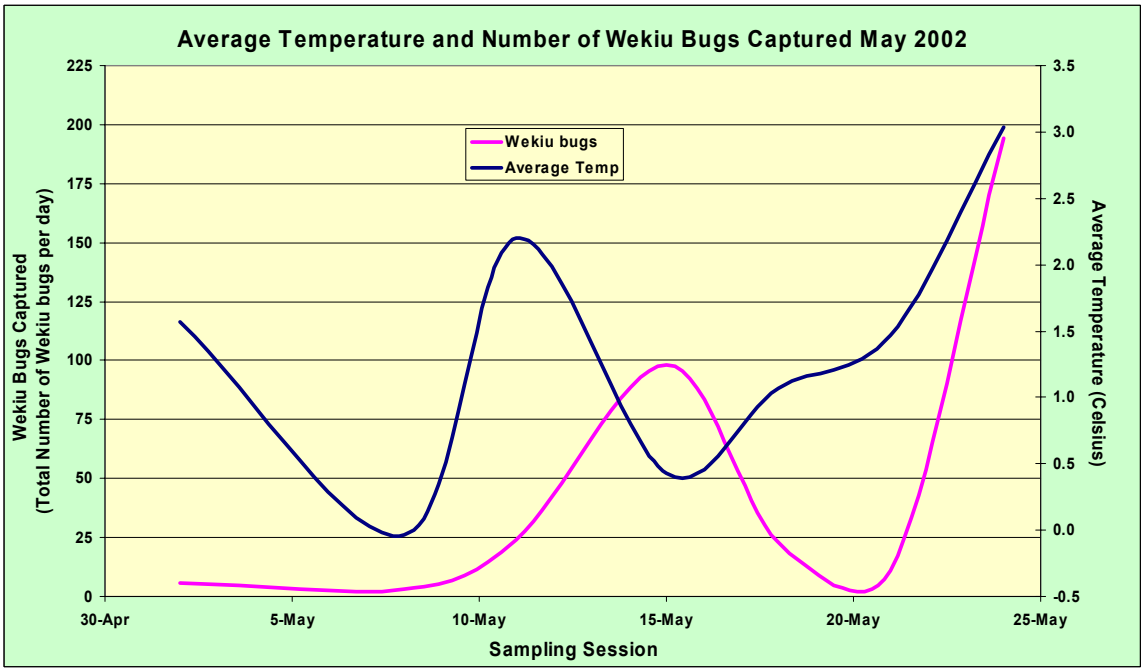


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in 2nd Quarter 2002.

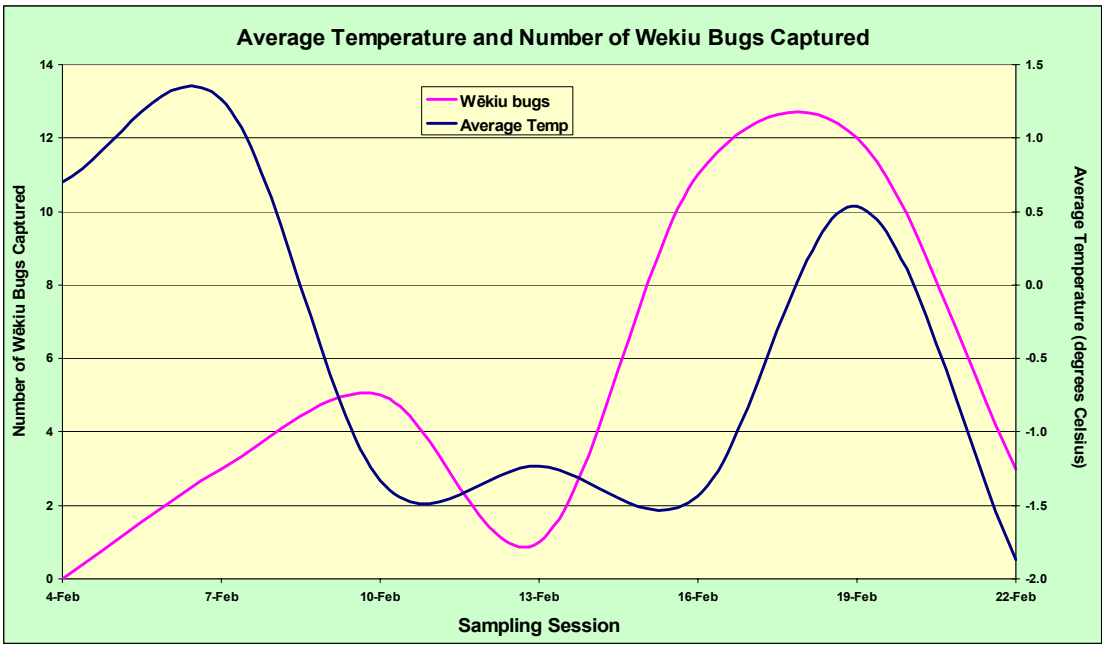


FIGURE 4. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured for Seven Sampling Periods in 1st Quarter 2002.

Pu‘u Hau ‘Oki Inner Slope Photographic Archive

NOVEMBER 2002

Pu‘u Hau ‘Oki inner slope
November 08, 2002

Pu‘u Hau ‘Oki inner slope
November 11, 2002

Pu‘u Hau ‘Oki inner slope
November 14, 2002

Pu‘u Hau ‘Oki inner slope
November 17, 2002

Pu'u Hau 'Oki inner slope
November 20, 2002

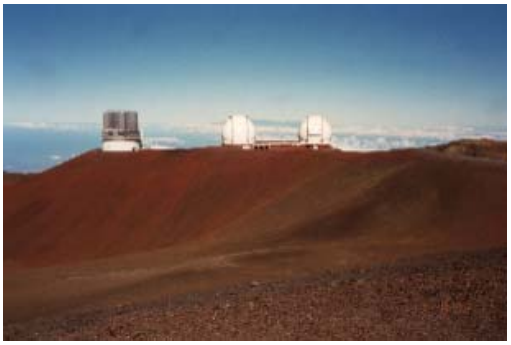
Pu'u Hau 'Oki inner slope
November 23, 2002

Pu'u Hau 'Oki inner slope
November 26, 2002

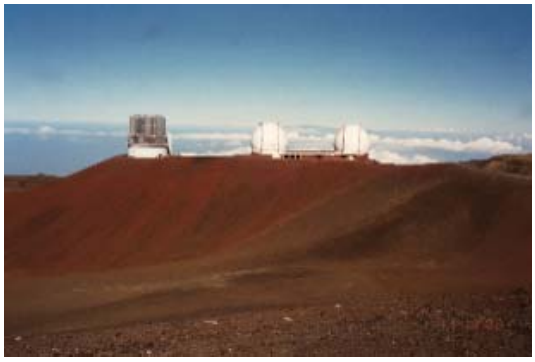
Pu'u Hau 'Oki inner slope
November 29, 2002

Pu'u Hau 'Oki Outer Slope Photographic Archive

NOVEMBER 2002

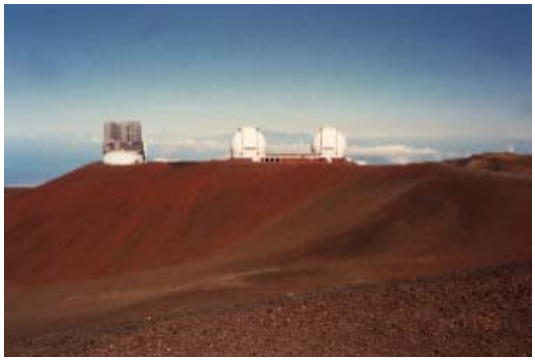


Pu'u Hau 'Oki outer slope
November 08, 2002

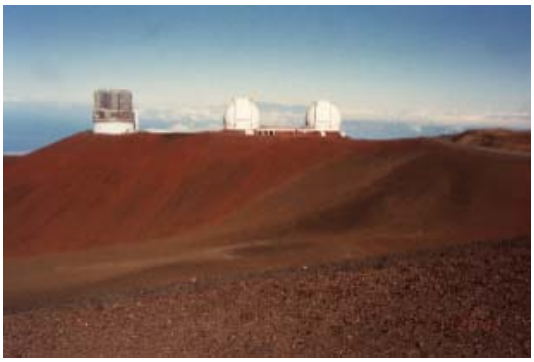


Pu'u Hau 'Oki outer slope
November 11, 2002

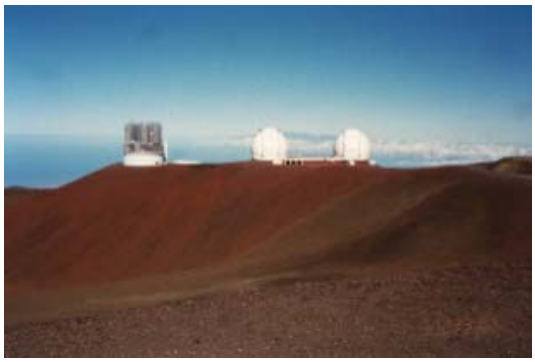
Pu'u Hau 'Oki outer slope
November 14, 2002



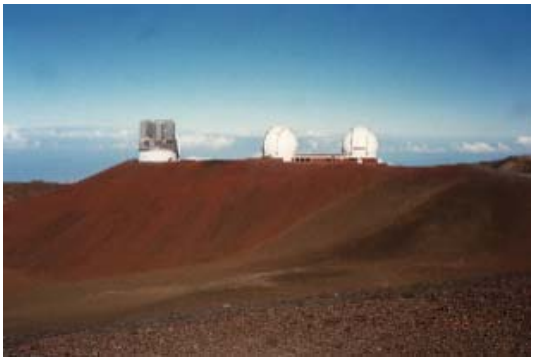
Pu'u Hau 'Oki outer slope
November 17, 2002



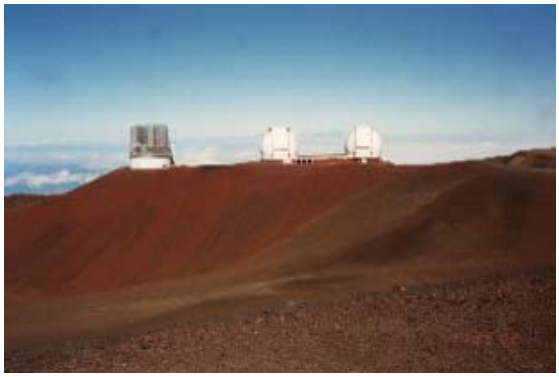
Pu'u Hau 'Oki outer slope
November 20, 2002



Pu'u Hau 'Oki outer slope
November 23, 2002



Pu'u Hau 'Oki outer slope
November 26, 2002



Pu'u Hau 'Oki outer slope
November 29, 2002

Pu‘u Wēkiu Photographic Archive

NOVEMBER 2002

Pu‘u Wēkiu inner slope
November 08, 2002

Pu‘u Wēkiu inner slope
November 11, 2002

Pu‘u Wēkiu inner slope
November 14, 2002

Pu‘u Wēkiu inner slope
November 17, 2002

Pu'u Wēkiu inner slope
November 20, 2002

Pu'u Wēkiu inner slope
November 23, 2002

Pu'u Wēkiu inner slope
November 26, 2002

Pu'u Wēkiu inner slope
November 29, 2002

Pu'u Wēkiu and Hau Kea Photographic Archive

NOVEMBER 2002

Pu'u Wēkiu and Hau Kea
November 08, 2002

Pu'u Wēkiu and Hau Kea
November 11, 2002

Pu'u Wēkiu and Hau Kea
November 14, 2002

Pu'u Wēkiu and Hau Kea
November 17, 2002

Pu'u Wēkiu and Hau Kea
November 20, 2002

Pu'u Wēkiu and Hau Kea
November 23, 2002

Pu'u Wēkiu and Hau Kea
November 26, 2002

Pu'u Wēkiu and Hau Kea
November 29, 2002

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 Puʻu Hau ʻOki and five on the slopes of Puʻu Wēkiu. After a few days to allow the traps to settle in, the traps were baited and set. The first 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 second 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 third 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 fourth sampling session on November 8, 2002 and checked every third day beginning November 11 through November 29 (seven samples per trap).

During the November sampling session Wēkiu bugs appeared in eight of the ten traps, and a total of one hundred and forty-five Wēkiu bugs appeared in or near the traps. That represents about a four-fold increase over trap captures in February 2002, about 40% of the May 2002 capture rate, and almost the same as the August trap captures (154 Wēkiu bugs). About ninety-six percent of the Wēkiu bugs captured appeared in live-traps on Puʻu Hau ʻOki. Only six appeared in live-traps on Puʻu Wēkiu (compared to only two Wēkiu bugs captured on Puʻu Wēkiu in the February and May sampling sessions combined, and eleven during the August sampling session). 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.

The trap capture rate on Puʻu Hau ʻOki during the November 2002 Baseline Monitoring session ranged from 0.6 to 12.2 Wēkiu bugs per trap per 3-days (Table 1). The trap capture rate in February, May, and August

2002 ranged from 0 to 2.4, 1.2 to 38.8, and 2.6 to 6.6 Wēkiu bugs per trap per 3-days respectively. During the 1997/98 MKSR Arthropod Assessment, average trap capture rates on Puʻu Hau ʻOki ranged from 0 to 1.1 Wēkiu bugs (Table 3). During fourth quarter monitoring on Puʻu Wēkiu the trap capture rate ranged from 0 to 0.4 Wēkiu bugs. During the 1997/98 study trap capture rates ranged from 0 to 0.15 Wēkiu bugs (Table 3).

The November average trap capture rate in Puʻu Hau ʻOki was 3.97 Wēkiu bugs per trap per 3 days of sampling (Table 2). There was no comparable period measured during the 1997/98 Arthropod Assessment. The November Wēkiu bug capture rate was about four times greater than in February, less than one-half the capture rate measured in May, and about the same as that measured in August. It appears that Wēkiu bugs were more active in May 2002 than during any other period measured in 2002. Activity during November appeared to be similar to that measured during August 2002.

The average trap capture rate on Puʻu Wēkiu was 0.17 Wēkiu bugs per trap per 3 days of sampling (Table 3). This is six times the rate measured in February or May 2002 and only one-half that measured in August 2002. During the 1997/98 study the average rate was 0.11 Wēkiu bugs per trap per 3 days of sampling (Table 3). It was noted during February and May 2002 Baseline Monitoring that the cinder slopes of Puʻu Wēkiu remained frozen longer than those on Puʻu Hau ʻOki. Snow persisted longer on Puʻu Wēkiu as well (see Photographic Archive). It is possible that the snow and frozen cinder hindered Wēkiu bug activity and that once the cinder thawed, Wēkiu bug activity increased. The trap capture rate on Puʻu Wēkiu in November may not be considered biologically different from that measured in August.

The Wēkiu bug population has apparently increased since 1998. The number of Wēkiu bugs captured during the 3-week sampling session (145 Wēkiu bugs in ten traps over seven 3-day trap periods) was about five times the number collected during the five one-week sampling sessions over 18 months of sampling for the 1997/98 Arthropod Assessment (30 Wēkiu bugs in one hundred fifty-five 3-day trap periods) on Puʻu Hau ʻOki and Puʻu Wēkiu. Over the entire 2002 Baseline Monitoring six hundred and ninety-six Wēkiu bugs were captured in traps. This is more than 23 times the amount captured during the 1997/98 Arthropod Assessment.

Unfortunately not all Wēkiu bugs survived in the live-traps. About 56%

of the captured Wēkiu bugs survived and were released. The November mortality rate was almost double the mortality rate observed in the August sampling session. There is no reliable information to explain this difference.

About 18% of the Wēkiu bugs captured during the November sampling session were juveniles. In August, nearly 23% of all Wēkiu bugs captured were juveniles. Apparently, Wēkiu bugs are breeding. 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 seem to vary with average air temperature (Figure 1, Figure 2, Figure 3, and Figure 4). The highest trap captures occurred when average air temperature was higher, and dropped off when air temperature was 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 sampling sessions is consistent with the hypothesis that Wēkiu bug activity may be regulated by temperature.

Other Observations

The W.M. Keck Observatory has continued to employ Wēkiu bug protection measures recommended in the Wēkiu Bug Mitigation Report (Pacific Analytics, 2000). These protection measures were specifically designed to protect Wēkiu bugs during the proposed Outrigger Telescopes Project, and their implementation will continue to protect Wēkiu bugs and their habitat during regular WMKO operations.

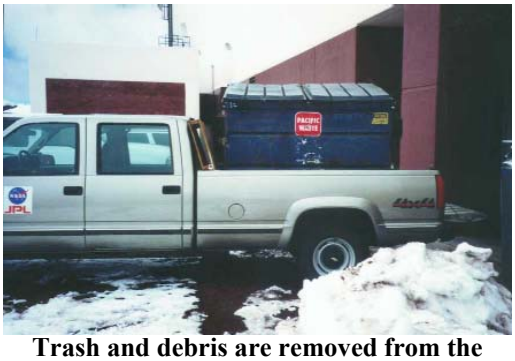
DEIMOS camera tractor and trailer at the WMKO site.

For example, during the First Quarter Baseline Monitoring session, a new camera device was added to the Keck Observatory (WMKO). The device, called the Deep Imaging Multi-Object Spectrograph (DEIMOS), was transported to the WMKO site on February 16, 2002.

The tractor and trailer were pressure-washed before advancing up the

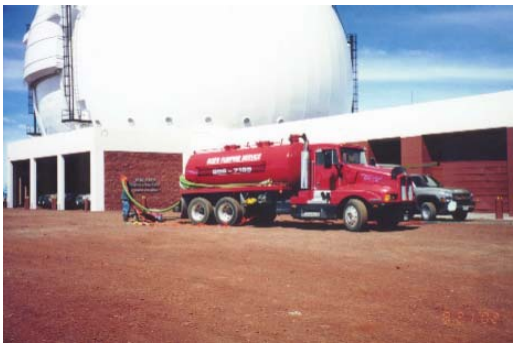
Mauna Kea Access Road. The tractor and trailer were inspected for alien arthropods by a Pacific Analytics entomologist and found to be free of any signs of ants and spiders.

During the Second Quarter Baseline Monitoring a truck sent to retrieve waste packaging products from the DEIMOS camera shipping container was inspected for non-indigenous arthropods. The truck had apparently been pressure-washed because the undercarriage was clean and free of any alien arthropods. Also during this period solid trash was removed from the WMKO site in this container. An inspection of the truck and trash container found them clean and free of any arthropods.



Trash and debris are removed from the WMKO in covered waste containers.

The WMKO septic tank was serviced during Baseline Monitoring in August. The process was watched, and it was observed that workers were careful to limit their activity to the immediate area of the septic tank opening. The activity occurred at least seventy-five feet from the nearest Wēkiu bug habitat.



Septic tank at WMKO is pumped periodically by septic tank professionals.

The pumping truck was inspected and found to be very clean, and was free of alien arthropods and mud.

No large trucks were observed at the WMKO during the November 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.

Wheel wells and undercarriage of the pumping truck were inspected and found to be free of alien arthropods.