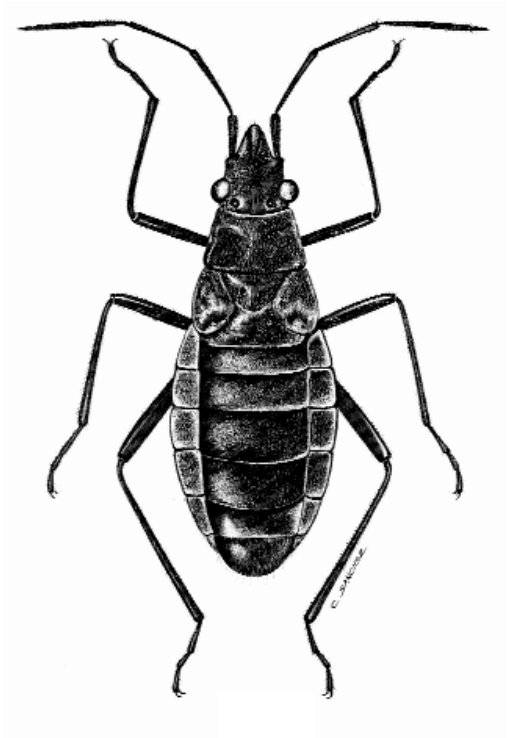
WĒKIU BUG

BASELINE MONITORING

QUARTERLY REPORT
3rd QUARTER 2005



Pacific Analytics, L.L.C.

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QUARTERLY REPORT
3rd QUARTER 2005

Prepared for

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

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

WĒKIU BUG BASELINE MONITORING

QUARTERLY REPORT
3rd QUARTER 2005

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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 occurs on the upper elevations of Mauna Kea. Populations of Wēkiu bugs also occur on other cinder cones above about 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?

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. Twenty live-traps stations were installed at the summit of Mauna Kea at designated locations, ten on Puʻu Hauʻoki and ten on Puʻu Wēkiu.

The 3rd Quarter 2005 three-week sampling session was conducted from July 15, 2005 through August 05, 2005. During this sampling session a total of 507 Wēkiu bugs appeared in or near the live-traps. Four hundred nineteen Wēkiu bugs were found on Puʻu Hauʻoki and eighty-eight were found on Puʻu Wēkiu. Sampling period trap capture rates ranged from 0.4 to 8.0 Wēkiu bugs per trap per 3 days of sampling.

The average trap capture rate on Puʻu Hauʻoki during the 3rd Quarter 2005 monitoring session was 5.99 Wēkiu bugs per trap per 3 days of sampling. This rate is about half of the highest average capture rate measured on Puʻu Hauʻoki during a 3rd Quarter baseline monitoring session (12.4 WB 2003), and about fifteen times higher than the low measured (0.4 WB 2004).

The average trap capture rate on Puʻu Wēkiu during the 3rd Quarter 2005 monitoring session was 1.26 Wēkiu bugs per trap per 3 days of sampling. This rate is about 2.5 times greater than any 3rd Quarter since Baseline Monitoring began in 2002.

Twenty-one percent (109/507) of the Wēkiu bugs captured in the 3rd Quarter 2005 sampling session were immature stages. The ratio was about the same on both Puʻu Hauʻoki and on Puʻu Wēkiu.

Trap mortality was about 6% (31 of 507). The improvements to the special live-traps appear to have reduced trap-caused mortality.

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.

The Hawai'i Department of Land and Natural Resources (DLNR) approved a recommendation for doubling the number of traps for Wēkiu bug monitoring. Five new monitoring stations were established on Pu'u Hau'oki and five on Pu'u Wēkiu during the 3rd Quarter 2004 monitoring session. All of the traps deployed for Wēkiu Bug Baseline Monitoring continue to be of the improved live-trap design described in previous quarterly reports.

This is the fifteenth Quarterly Report of Baseline Monitoring. The results of the sampling effort conducted July 15, 2005 through August 05, 2005 are reported. Comparisons to previously collected data are presented, along with new analysis and interpretations of correlations of changes in Wēkiu bug populations with weather related phenomena.

A Linyphiidae spider observed near a trap on Pu'u Wēkiu during the 3rd Quarter 2005 sampling session (Photo taken July 27, 2005).The spider is about 3 mm in total length.

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 Puʻu Hauʻoki crater and undisturbed Wēkiu bug habitat at Puʻu 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.

A third instar nymph Wēkiu bug. Actual size is about 3 mm.
Picture taken July 2005.

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.

During the 3rd Quarter 2005 sampling session twenty live-traps were open for the entire sampling session, 10 traps on Puʻu Hauʻoki and 10 traps on Puʻu Wēkiu. Traps were set at the same monitoring stations installed during previous sampling sessions.

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.

Monitoring stations were established in previous sampling sessions 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 at each available monitoring station 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 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, or as weather permitted. 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 arthropods 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 monitoring stations will be used for future sampling.

Traps were opened for the 3rd Quarter 2005 baseline monitoring session on July 15, 2005. The traps were checked every three days beginning July 18, 2005 and were closed on August 05, 2005. Summit weather conditions did not impede sampling during this quarter of monitoring.

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

In order to improve the accuracy of temperature measurements and more closely correlate them with trap capture rates, data loggers were placed on each of the sampled cinder cones, Puʻu Hauʻoki and Puʻu Wēkiu at the request of the Office of Mauna Kea Management (OMKM). Special permission for these data loggers was obtained from the Hawaiʻi Department of Land and Natural Resources (DLNR). The data loggers were placed near the middle of the sampled slopes at the top of the ash layer and covered with native cinder to the original depth (about 4-6 inches). The data loggers measure and record temperature and humidity every 15 minutes. Data was downloaded every three days using a data shuttle. Data loggers used are the HOBO© H8 Pro Series model number H08-030-08 from Onset (www.onsetcomp.com). The HOBO© Shuttle, model number H09-003-08 was used to download temperature data from the loggers.

Weather data have been collected using the data loggers since the 3rd Quarter 2004 monitoring session. This information represents measurements of substrate conditions. Before the 2nd Quarter 2004, weather information was obtained from the UKIRT Observatory Weather Station and represented general conditions of the summit area.

Archive photographs were taken from fixed points on Puʻu Hauʻoki and on Puʻu Wēkiu. Photographs were taken at the beginning of each sampling period to record snow coverage and other changes in Wēkiu bug habitats through time.

HOBO© Temperature Data Logger.

VI. RESULTS

SAMPLING

During the 3rd Quarter 2005 baseline monitoring session there were a total of twenty-one sampling nights, making seven 3-day sampling periods.

A total of five hundred and seven Wēkiu bugs were captured, four hundred and nineteen were captured on Puʻu Hauʻoki and eighty-eight on Puʻu Wēkiu. The trap capture rate (number of Wēkiu bugs per trap per 3-days) ranged from 0.4 to 8.0 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 5.99 (±0.63) Wēkiu bugs for Puʻu Hauʻoki, and 1.26 (±0.27) Wēkiu bugs for Puʻu Wēkiu (Table 1). For perspective, average trap capture rates from previous baseline monitoring sessions and the 1982 and 1997/98 Arthropod Assessments are provided (Table 2 and Table 3). Average trap capture rates reported for the 1982 and 1997/98 arthropod assessments are those measured in comparable locations on Puʻu Hauʻoki crater and Puʻu Wēkiu as those measured for Wēkiu Bug Baseline Monitoring. The 1982 measurements were recorded during July and August.

Figure 1 graphs the average trap capture rates for all Baseline Monitoring on Puʻu Hauʻoki (beginning 1st Quarter 2002). Figure 2 shows the quarterly variation in average trap capture rates for Baseline Monitoring on Puʻu Hauʻoki.

Twenty-one percent (109/507) of the Wēkiu bugs captured in the 3rd Quarter 2005 sampling session were immature stages. The ratio was about the same on both Puʻu Hauʻoki and on Puʻu Wēkiu.

Overall mortality was about 6% (31 of 507). This mortality rate is significantly less than the 40% experienced with the previous live-trap design used in the 1997/98 arthropod assessment. Eighteen of the thirty-one dead Wēkiu bugs were in traps that contained captured spiders. Many of the dead bugs had missing legs and other evidence that they had been predated by the spiders. Mortality due directly to the traps was probably much less than the 6% observed.

TABLE 1.
3rd QUARTER 2005 SAMPLING PERIOD
AVERAGE TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each sampling period during 3rd Quarter 2005 Baseline Monitoring.

Location	7/18/2005	7/21/2005	7/24/2005	7/27/2005	7/30/2005	8/2/2005	8/5/2005	AVERAGE ± SE
Puʻu Wēkiu	1.00	2.20	2.30	1.20	1.00	0.40	0.70	1.26 ± 0.27
Puʻu Hauʻoki	4.30	5.10	8.00	7.90	7.10	4.10	5.40	5.99 ± 0.63

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	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Year Avg.
Puʻu Wēkiu 2002*	0.03	0.03	0.3	0.2	0.1
Puʻu Wēkiu 2003	2.8	11.5	0.5	0.0	3.7
Puʻu Wēkiu 2004	0.00	2.0	0.03	0.06	0.5
Puʻu Wēkiu 2005	1.14	0.64	**1.26**		1.01
Puʻu Hauʻoki 2002	1.0	10.3	4.0	4.0	4.8
Puʻu Hauʻoki 2003	18.5	90.6	12.4	0.8	30.6
Puʻu Hauʻoki 2004	2.1	8.8	0.4	0.21	2.9
Puʻu Hauʻoki 2005	15.92	5.09	**5.99**		9.00

* - different trap locations on Puʻu Wēkiu in 2002

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 1982 and 1997/98 Arthropod Assessments. Average trap capture rates for the 1997/98 Arthropod Assessment are in RED.

Location	Aug. 1997	Jan. 1998	Apr-98	Jul-98	1997/98 Avg.	Jul-82
Puʻu Wēkiu	0.15	0	0.07	0.15	0.11	225
Puʻu Hauʻoki	0.2	0	0.2	1.1	0.38	105.6

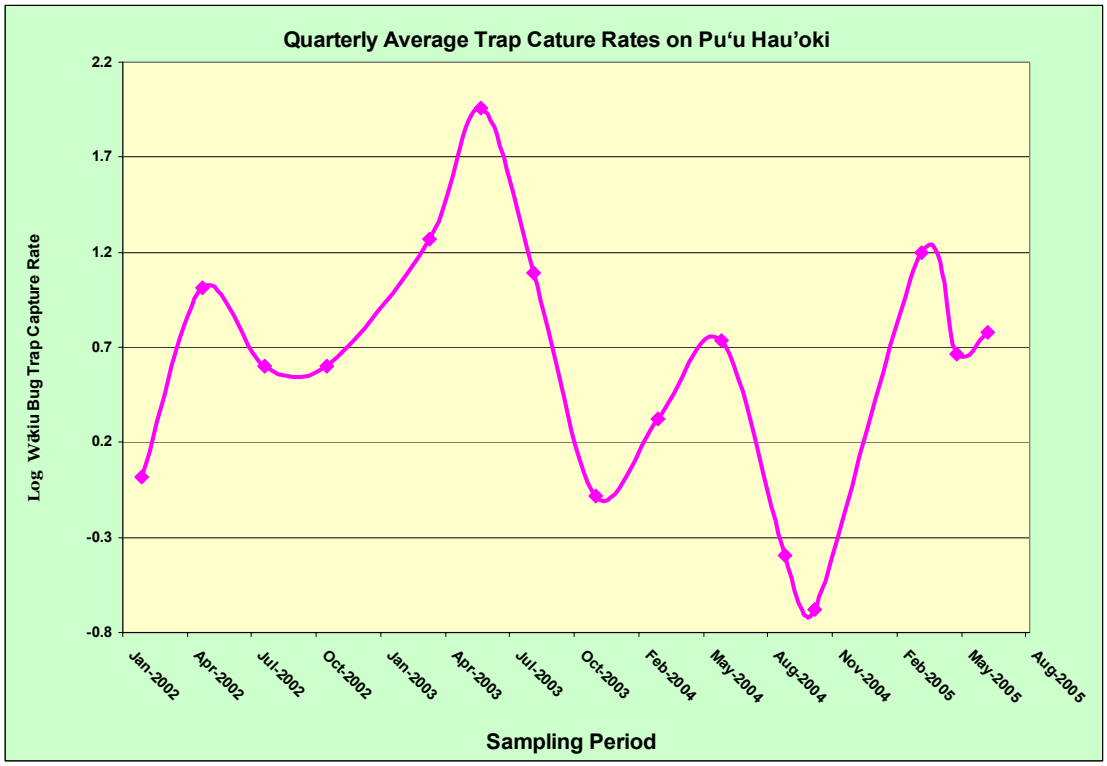


FIGURE 1. Graph of the Log Average Wēkiu Bug Trap Capture Rate per Sampling Period on Pu'u Hau'oki since Wēkiu Bug Baseline Monitoring began in February 2002.

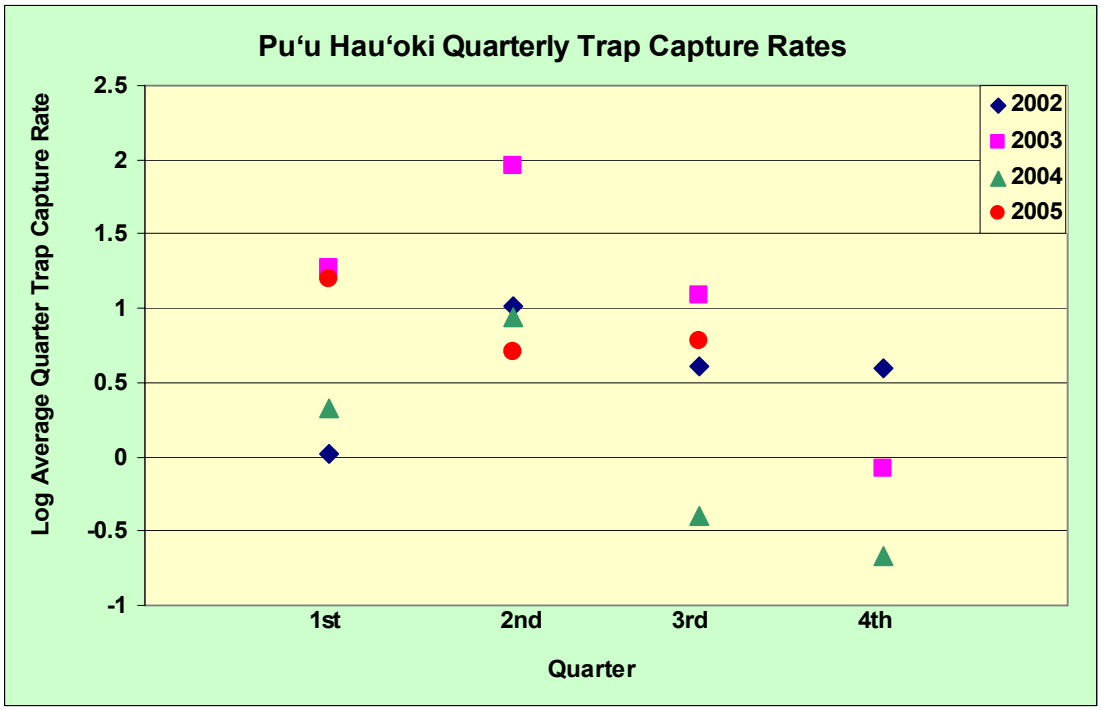


Figure 2. Pu'u Hau'oki Quarterly Average Trap Capture Rates.
The log average quarterly trap capture rate of Wēkiu bugs on Pu'u Hau'oki for four years of Wēkiu Bug Baseline Monitoring.

WEATHER INFORMATION

In past monitoring sessions, weather data was collected from nearby observatories that measure air temperature near those buildings. Because the two measurements appear to be quite different, new graphs will be presented that compare temperature and trap capture data for each quarterly sampling session (see Figure 3). Figure 4 will no longer be updated.

Figure 3 is a graph of the number of Wēkiu bugs captured in trap and average temperature for the 3rd Quarter 2005 monitoring session. Temperature data is derived from HOBO© data loggers. In the previous monitoring sessions there was a strong indication that as average temperature decreased, the number of Wēkiu bugs in the traps also decreased. And as temperatures increased the number of Wēkiu bugs in the traps increased.

During the 2nd Quarter 2005 Baseline Monitoring session a new trend was observed. The number of Wēkiu bugs decreased as average temperatures increased over about 10°C. Average temperatures during the 3rd Quarter 2005 Baseline Monitoring session were higher than those recorded in previous monitoring sessions, and the number of Wēkiu bugs fell as temperatures rose above about 7-10°C, and increased as average temperatures dropped to about 6°C. Evidently there is a maximum temperature above which Wēkiu bugs cease their foraging activity.

Graphs of previous monitoring sessions (before 2nd Quarter 2004) were based on temperature data collected by the UKIRT Observatory. Weather information was not available for the 2nd Quarter 2004 monitoring session due to damage at the UKIRT weather station. A Graph of the log average Wēkiu bug trap capture rate plotted with average temperature for quarterly sampling sessions up to the 2nd Quarter 2004 sampling session appears in Figure 4.

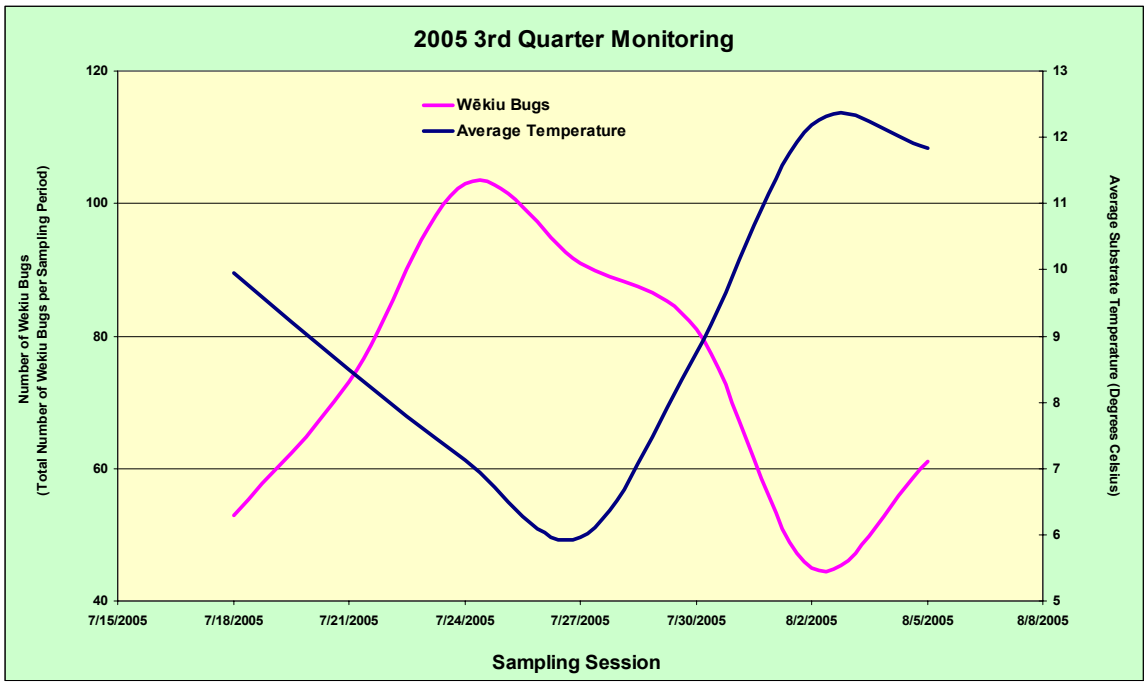


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured per Sampling Period at all sampling locations during the 3rd Quarter 2005 sampling session.

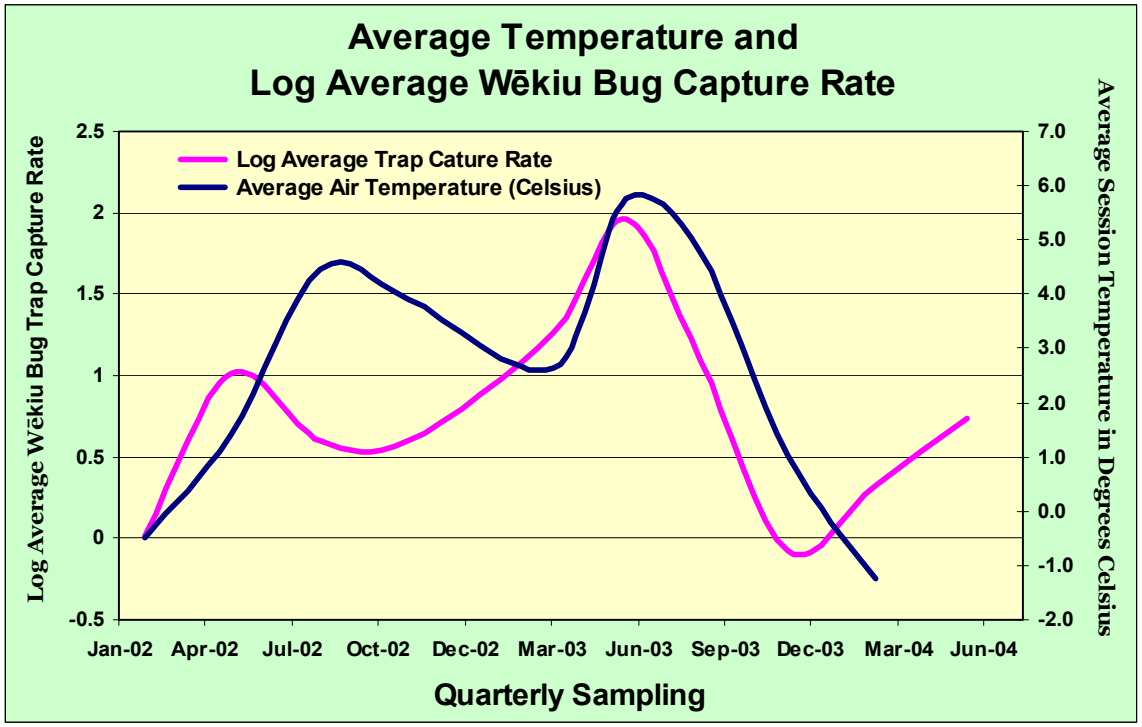


FIGURE 4. Plot of Baseline Monitoring Session Average Temperature (Celsius) and Natural Log Average Number of Wēkiu Bug Trap Capture Rate per Session on Puʻu Hauʻoki.

Pu‘u Hau‘oki Inner Slope Photographic Archive

JULY - AUGUST 2005
TRAPS 1 - 5

Pu‘u Hau‘oki inner slope
July 15, 2005

Pu‘u Hau‘oki inner slope
July 18, 2005

Pu‘u Hau‘oki inner slope
July 21, 2005

Pu‘u Hau‘oki inner slope
July 24, 2005

TRAPS 1 - 5

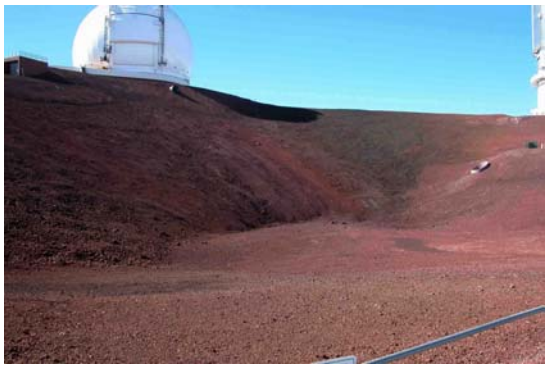
Puʻu Hauʻoki inner slope
July 27, 2005

Puʻu Hauʻoki inner slope
July 30, 2005

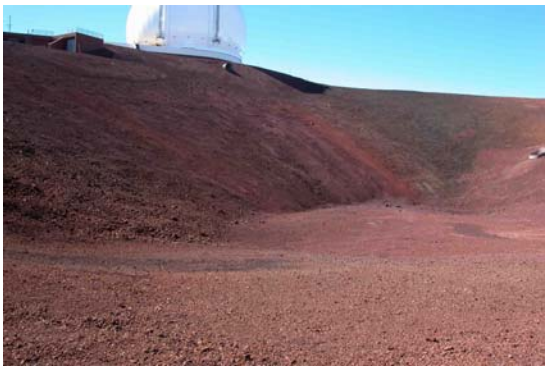
Puʻu Hauʻoki inner slope
August 02, 2005

Puʻu Hauʻoki inner slope
August 05, 2005

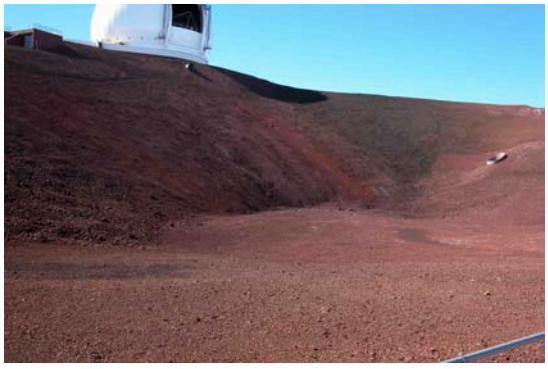
JULY - AUGUST 2005
TRAPS 6 - 10



Pu'u Hau'oki inner slope
July 15, 2005



Pu'u Hau'oki inner slope
July 18, 2005

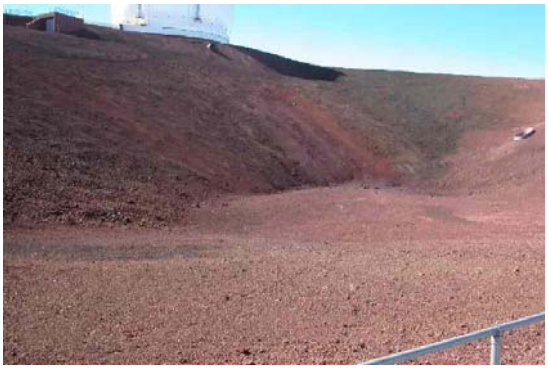


Pu'u Hau'oki inner slope
July 21, 2005

Pu'u Hau'oki inner slope
July 24, 2005

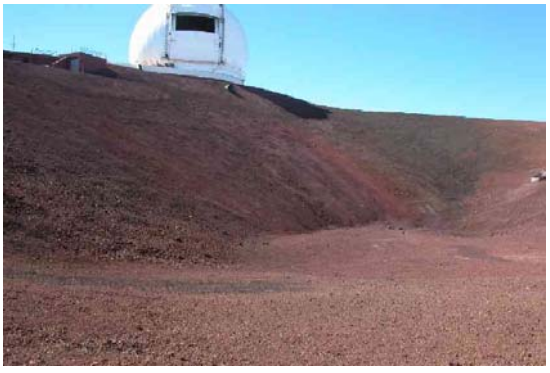
TRAPS 6 - 10

Pu'u Hau'oki inner slope
July 27, 2005



Pu'u Hau'oki inner slope
July 30, 2005

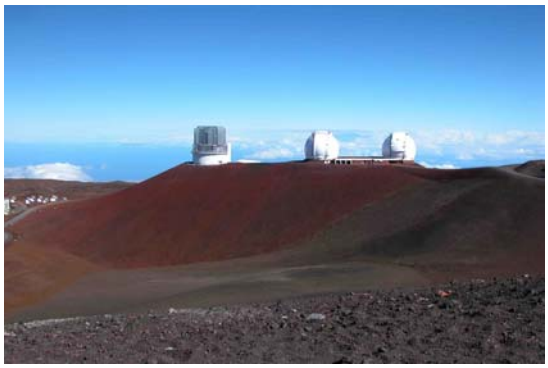
Pu'u Hau'oki inner slope
August 02, 2005



Pu'u Hau'oki inner slope
August 05, 2005

Pu'u Hau'oki Outer Slope Photographic Archive

JULY - AUGUST 2005



Pu'u Hau'oki outer slope
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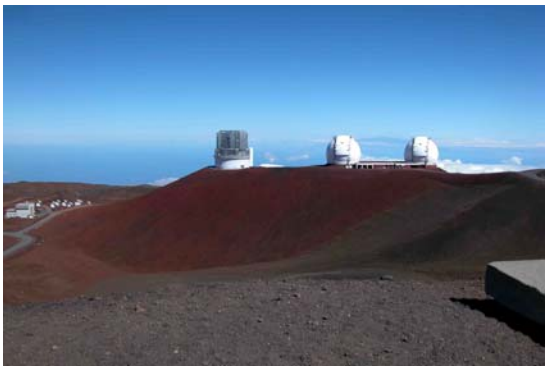

Pu'u Hau'oki outer slope
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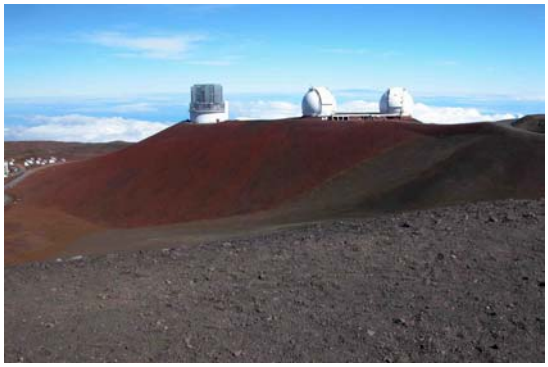
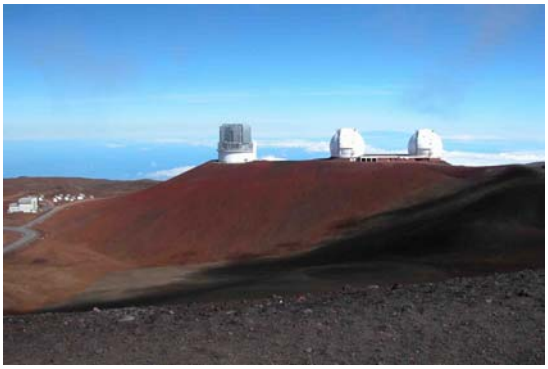
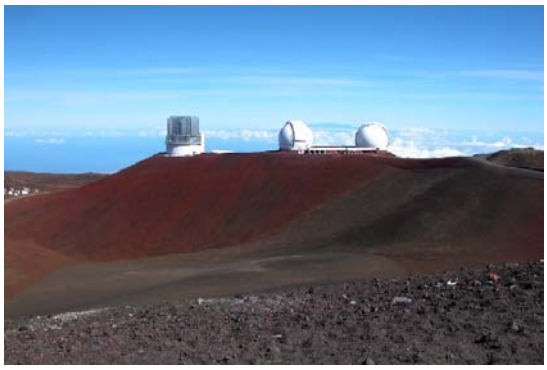


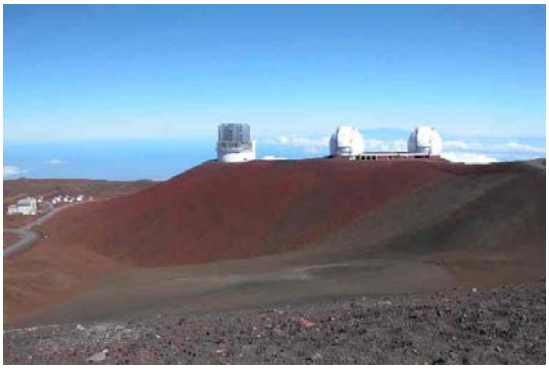
Pu'u Hau'oki outer slope
July 21, 2005



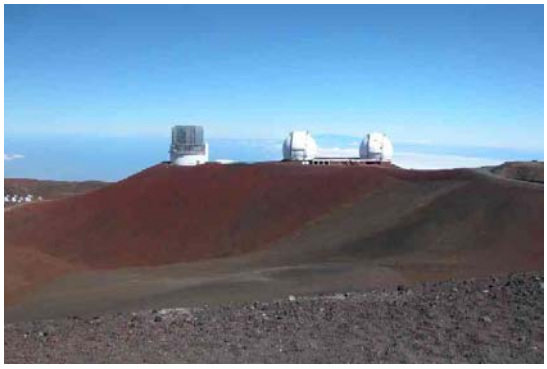
Pu'u Hau'oki outer slope
July 24, 2005



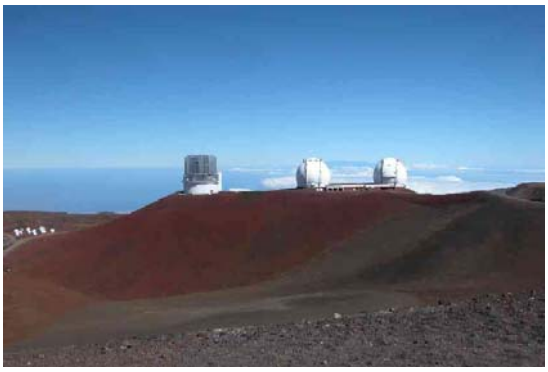
Puʻu Hauʻoki outer slope
July 27, 2005



Puʻu Hauʻoki outer slope
July 30, 2005



Puʻu Hauʻoki outer slope
August 02, 2005



Puʻu Hauʻoki outer slope
August 05, 2005

Pu‘u Wēkiu Photographic Archive

JULY - AUGUST 2005
TRAPS 1 - 5

Pu‘u Wēkiu inner slope
July 15, 2005

Pu‘u Wēkiu inner slope
July 18, 2005

Pu‘u Wēkiu inner slope
July 21, 2005

Pu‘u Wēkiu inner slope
July 24, 2005

TRAPS 1 - 5

Pu'u Wēkiu inner slope
July 27, 2005

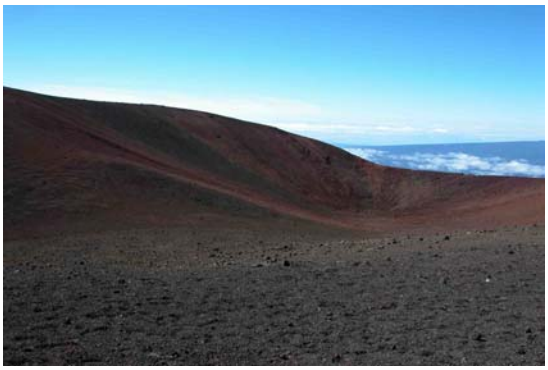
Pu'u Wēkiu inner slope
July 30, 2005

Pu'u Wēkiu inner slope
August 02, 2005

Pu'u Wēkiu inner slope
August 05, 2005

JULY - AUGUST 2005
TRAPS 6 - 10

Pu'u Wēkiu inner slope
July 15, 2005



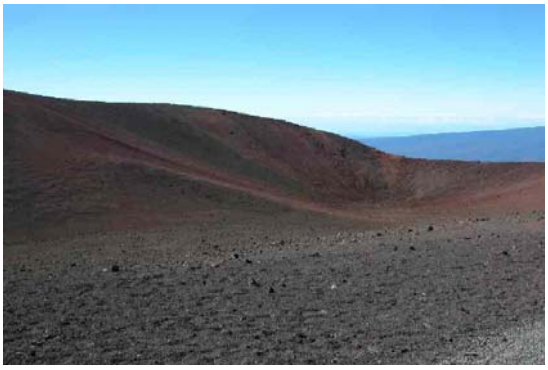
Pu'u Wēkiu inner slope
July 18, 2005

Pu'u Wēkiu inner slope
July 21, 2005

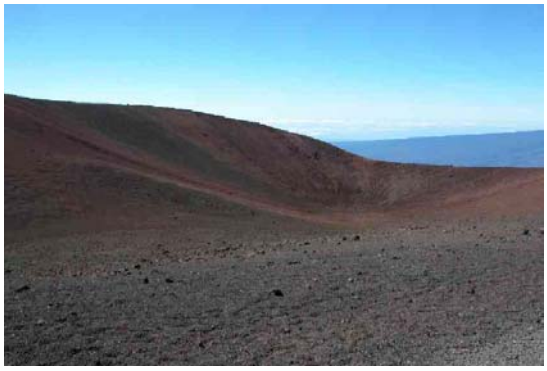
Pu'u Wēkiu inner slope
July 24, 2005

TRAPS 6 - 10

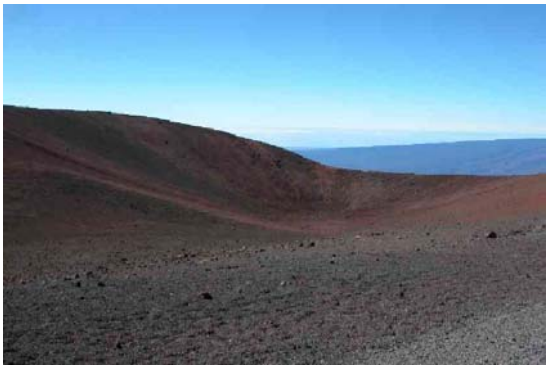
Pu'u Wēkiu inner slope
July 27, 2005



Pu'u Wēkiu inner slope
July 30, 2005



Pu'u Wēkiu inner slope
August 02, 2005



Pu'u Wēkiu inner slope
August 05, 2005

Pu‘u Wēkiu and Pu‘u Hau Kea Photographic Archive

JULY - AUGUST 2005

Pu‘u Wēkiu and Pu‘u Hau Kea
July 15, 2005

Pu‘u Wēkiu and Pu‘u Hau Kea
July 18, 2005

Pu‘u Wēkiu and Pu‘u Hau Kea
July 21, 2005

Pu‘u Wēkiu and Pu‘u Hau Kea
July 24, 2005

Pu'u Wēkiu and Pu'u Hau Kea
July 27, 2005

Pu'u Wēkiu and Pu'u Hau Kea
July 30, 2005

Pu'u Wēkiu and Pu'u Hau Kea
August 02, 2005

Pu'u Wēkiu and Pu'u Hau Kea
August 05, 2005

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-trap monitoring stations 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.

4th Instar Wēkiu bug nymph captured in 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 4.82 bugs per trap per 3-day trapping period on Pu'u Hau'oki, and 0.13 bugs per trap per 3-day trapping period on Pu'u Wēkiu.

Over the four quarters of monitoring during 2003, 4,237 Wēkiu bugs were captured in live-traps. Wēkiu bug trap capture rates averaged 30.57 bugs per trap per 3-day trapping period on Pu'u Hau'oki, and 3.71 bugs per trap per 3-day trapping period on Pu'u Wēkiu.

Over the four quarters of monitoring during 2004, 518 Wēkiu bugs were captured in live-traps. Wēkiu bug trap capture rates averaged 2.9 bugs per trap per 3-day trapping period on Pu'u Hau'oki, and 0.5 bugs per trap per 3-day trapping period on Pu'u Wēkiu.

During the 1st Quarter 2005 sampling session a total of 458 Wēkiu bugs appeared in the traps. The average trap capture rate on Pu'u Hau'oki was 15.92 WB. The average trap capture rate on Pu'u Wēkiu was 1.14 WB.

During the 2nd Quarter 2005 sampling session a total of 370 Wēkiu bugs appeared in the traps. The average trap capture rate on Pu'u Hau'oki was 5.09 WB. The average trap capture rate on Pu'u Wēkiu was 0.64 WB.

During the 3rd Quarter 2005 sampling session Wēkiu bugs appeared in all of the traps on Pu'u Wēkiu and Pu'u Hau'oki. A total of 507 Wēkiu bugs appeared in or near the traps during the seven trapping sessions. All live

bugs were released back into their habitat.

Average 3rd Quarter 2005 trap capture rate on Puʻu Hauʻoki was 5.99 (±0.63) bugs per trap per 3-day trapping period. Average 3rd Quarter 2005 trap capture rate on Puʻu Wēkiu was 1.26(±0.27) bugs per trap per 3-day trapping period.

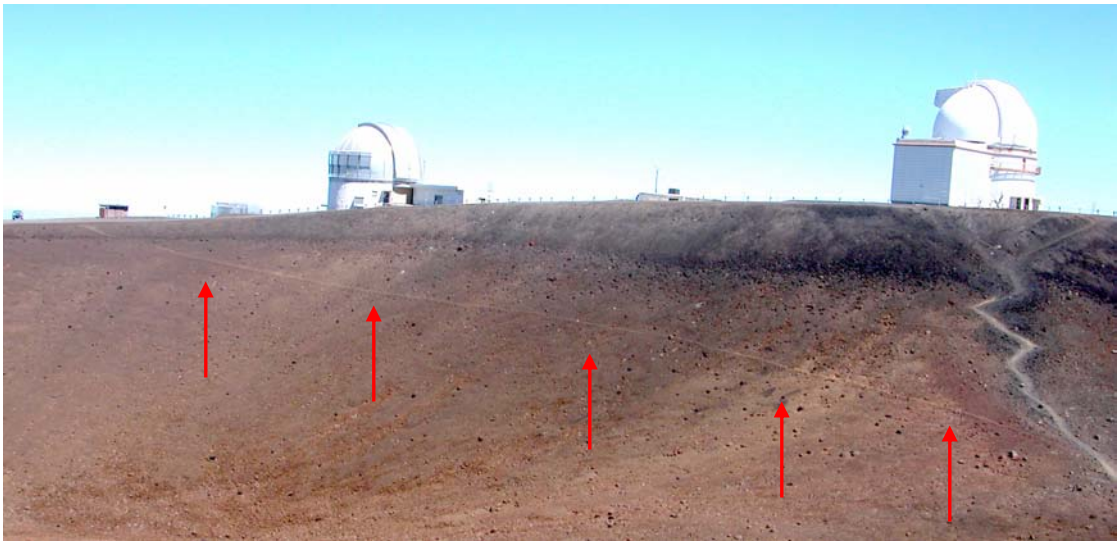
The average trap capture rate of 5.99 on Puʻu Hauʻoki during the 3rd Quarter 2005 monitoring session is about half of the highest average capture rate measured on Puʻu Hauʻoki during a 3rd Quarter baseline monitoring session (12.4 WB 2003) (Table 2), and about fifteen times greater than the lowest average capture rate measured on Puʻu Hauʻoki during a 3rd Quarter baseline monitoring session measured in 2004 (0.4 WB) and

The average trap capture rate on Puʻu Wēkiu during the 3rd Quarter 2005 monitoring session was 1.26 Wēkiu bugs per trap per 3 days of sampling. This rate is about 2.5 times greater than the previous high recorded in four years of baseline monitoring on Puʻu Wēkiu (0.5 WB 2003).

Twenty-one percent (109/507) of the Wēkiu bugs captured in the 3rd Quarter 2005 sampling session were immature stages. The presence of immature stages is strong evidence that the population of Wēkiu bugs on Mauna Kea is breeding.

Mauna Kea Rangers patrol the summit access road and help protect visitors and the natural environment.

About 6% (31 of 507) of the Wēkiu bugs captured during the 3rd Quarter 2005 sampling session died in live-traps. Many of the deaths were caused by spiders captured in the same traps. The improved live-traps appear to have significantly reduced trapping mortality compared to the 40% mortality measured in live-traps used during the 1997/98 arthropod assessment. In an effort to decrease mortality due to predation in the traps, larger pieces of cinder were placed in the traps to provide Wēkiu bugs refuge from the predators. The effectiveness of this change will be monitored in upcoming quarterly sessions.



A new trail has been established in Wēkiu bug habitat. Photo taken August 5, 2005.

Other Observations

During the 3rd Quarter 2005 monitoring session the WMKO site was free of loose trash and debris. Observatory vehicles parked near the WMKO were clean. Inspections of vehicles parked at the WMKO found no visible signs of alien arthropods.

A new trail appears to have been established in Wēkiu bug habitat. Rangers believe that the trail is the result of visitors from summit tour vans. Educational signs along the road would help to prevent visitors from disturbing this sensitive habitat.