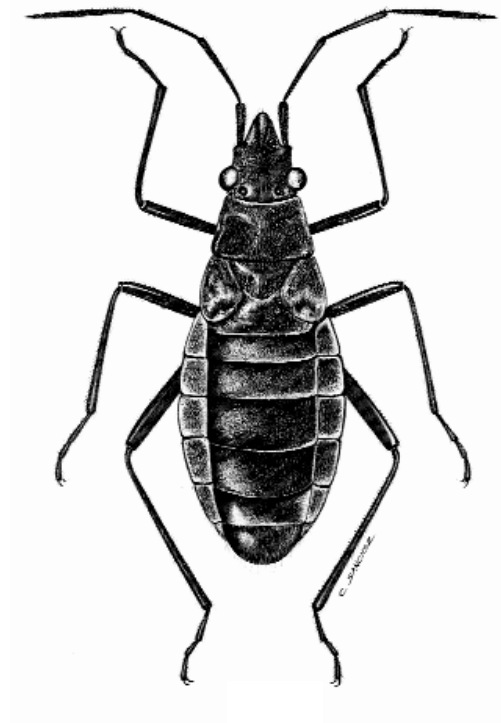


WĒKIU BUG

BASELINE MONITORING

QUARTERLY REPORT
4th QUARTER 2005



Pacific Analytics, L.L.C.

WĒKIU BUG
BASELINE MONITORING

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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 4th QUARTER 2005

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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

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
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
RESULTS

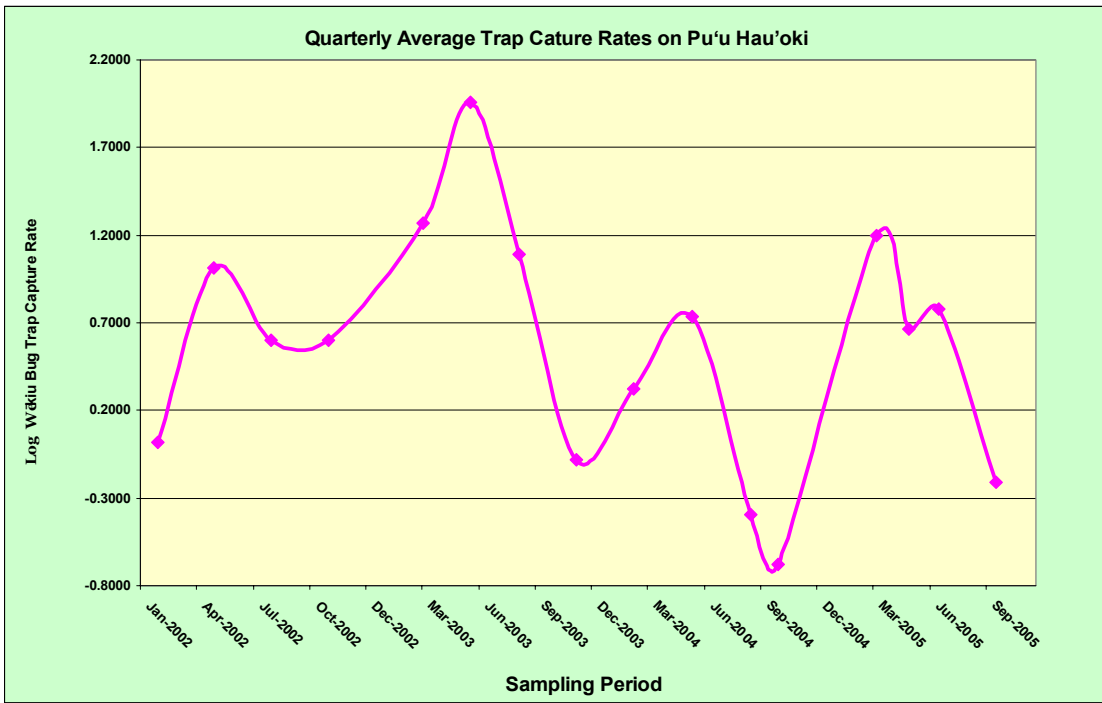


FIGURE 1. Graph of the log₁₀ Average Wēkiu Bug Trap Capture Rate per Sampling Period on Pu'u Hau'oki since Wēkiu Bug Baseline Monitoring began in February 2002.

Wēkiu Bug Baseline Monitoring
RESULTS

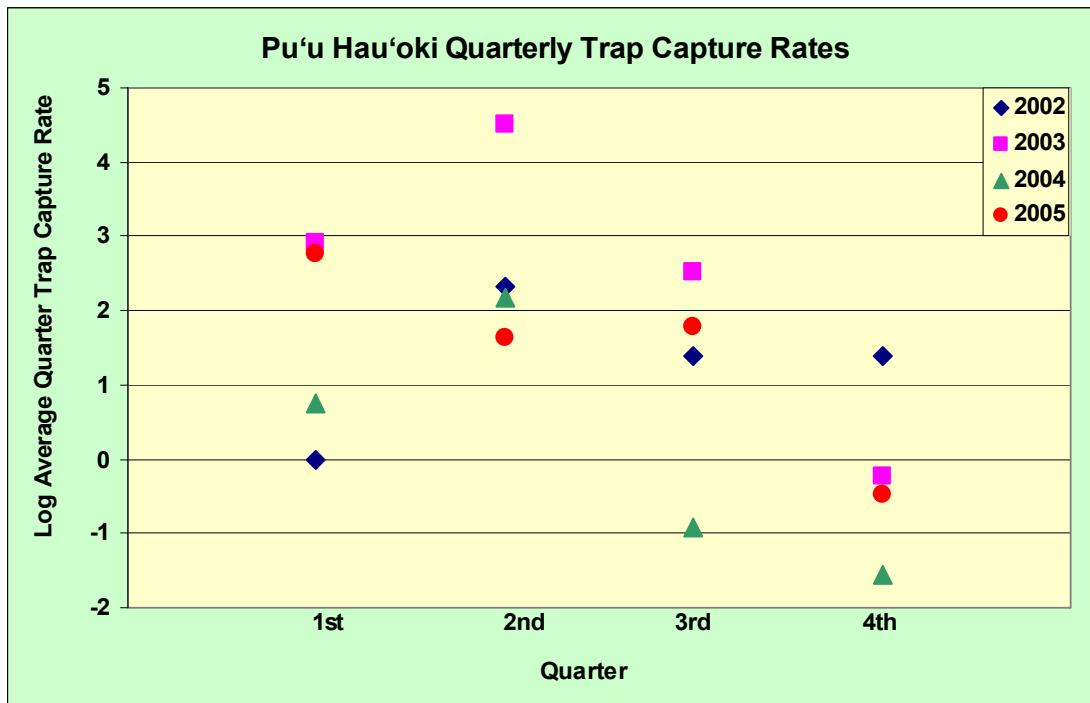


FIGURE 2. Pu'u Hau'oki Quarterly Average Trap Capture Rates.
 The \log_{10} average quarterly trap capture rate of Wēkiu bugs on Pu'u Hau'oki
 for four years of Wēkiu Bug Baseline Monitoring.

**Wēkiu Bug Baseline Monitoring
RESULTS**

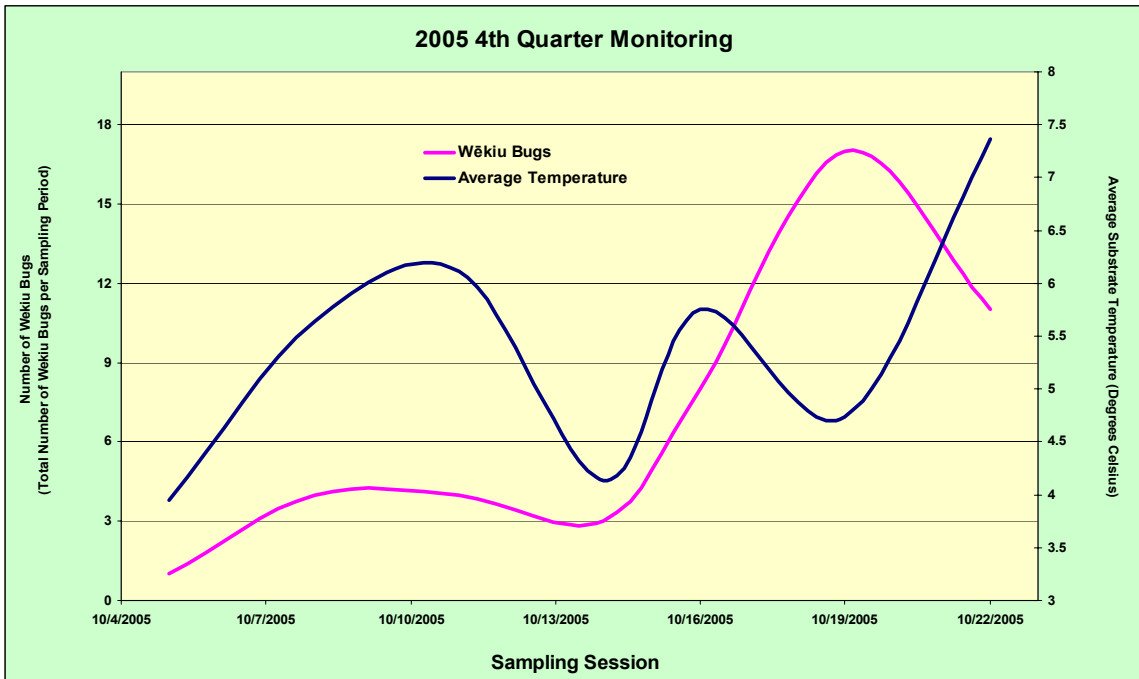


FIGURE 3. Plot of Average Temperature (Celsius) and Total Number of Wēkiu Bugs Captured per Sampling Period at all sampling locations during the 4th Quarter 2005 sampling session.

**Wēkiu Bug Baseline Monitoring
RESULTS**

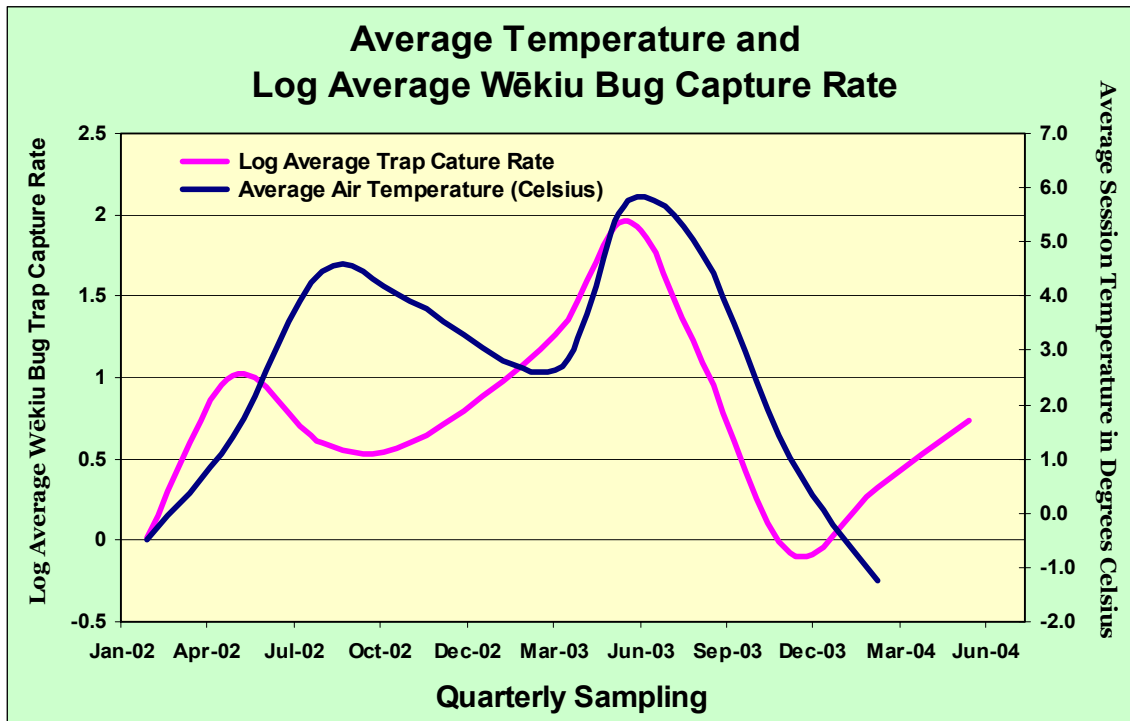


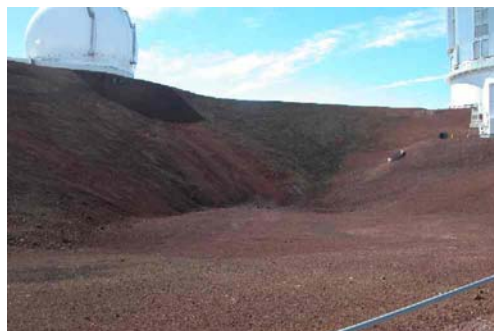
FIGURE 4. Plot of Baseline Monitoring Session Average Temperature (Celsius) and Natural Log Average Number of Wēkiu Bug Trap Capture Rate per Session on Pu‘u Hau‘oki.

Wēkiu Bug Baseline Monitoring
RESULTS

OCTOBER 2005
TRAPS 6 - 10



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



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



Pu'u Hau'oki inner slope
October 08, 2005



Pu'u Hau'oki inner slope
October 11, 2005

Wēkiu Bug Baseline Monitoring
RESULTS

TRAPS 6 - 10



**Pu'u Hau'oki inner slope
October 14, 2005**



**Pu'u Hau'oki inner slope
October 16, 2005**



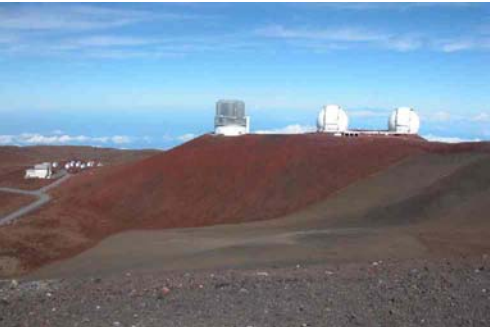
**Pu'u Hau'oki inner slope
October 19, 2005**



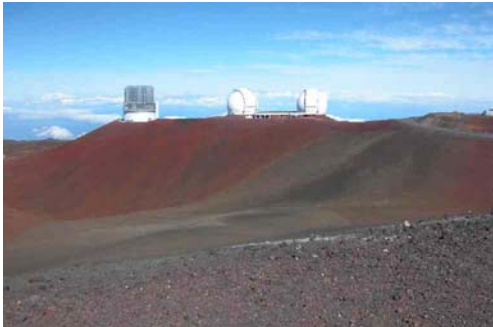
**Pu'u Hau'oki inner slope
October 22, 2005**

Pu’u Hau’oki Outer Slope Photographic Archive

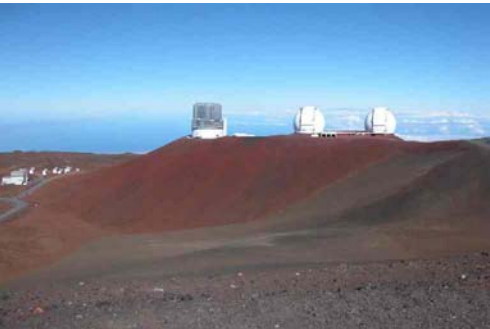
OCTOBER 2005



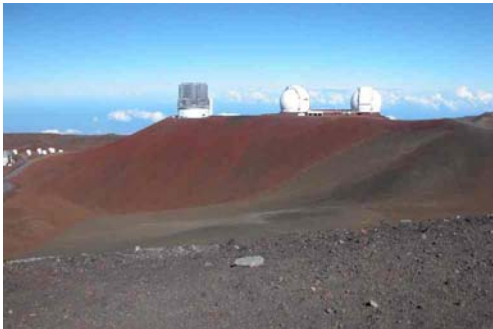
**Pu’u Hau’oki outer slope
October 02, 2005**



**Pu’u Hau’oki outer slope
October 05, 2005**



**Pu’u Hau’oki outer slope
October 08, 2005**

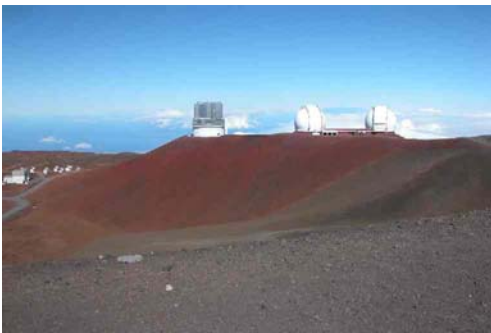


**Pu’u Hau’oki outer slope
October 11, 2005**

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**Wēkiu Bug Baseline Monitoring
RESULTS**

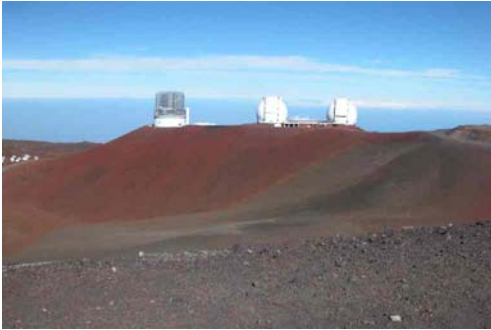
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**Pu'ū Hau'oki outer slope
October 14, 2005**



**Pu'ū Hau'oki outer slope
October 16, 2005**



**Pu'ū Hau'oki outer slope
October 19, 2005**



**Pu'ū Hau'oki outer slope
October 22, 2005**

Wēkiu Bug Baseline Monitoring
RESULTS

TRAPS 1 - 5



**Pu'u Wēkiu inner slope
October 14, 2005**



**Pu'u Wēkiu inner slope
October 16, 2005**



**Pu'u Wēkiu inner slope
October 19, 2005**



**Pu'u Wēkiu inner slope
October 22, 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.

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 a total of 507 Wēkiu bugs appeared in the traps. The average trap capture rate on Pu'u Hau'oki was 5.99 WB. The average trap capture rate on Pu'u Wēkiu was 1.26 WB.

During the 4th Quarter 2005 sampling session Wēkiu bugs appeared in all ten traps on Pu'u Hau'oki and five of the ten traps on Pu'u Wēkiu. A total of 48 Wēkiu bugs appeared in or near the traps during the seven trapping sessions. All live bugs were released back into their habitat.

Wēkiu Bug Baseline Monitoring
DISCUSSION

Average 4th Quarter 2005 trap capture rate on Pu'u Hau'oki was 0.62 (± 0.21) bugs per trap per 3-day trapping period. Average 4th Quarter 2005 trap capture rate on Pu'u Wēkiu was 0.12 (± 0.04) bugs per trap per 3-day trapping period.

The average trap capture rate of 0.62 on Pu'u Hau'oki during the 4th Quarter 2005 monitoring session is about one sixth of the highest average capture rate measured on Pu'u Hau'oki during a 4th Quarter baseline monitoring session (4.0 WB 2002) (Table 2), and about three times higher than the low (0.21 WB 2004)

The average trap capture rate on Pu'u Wēkiu during the 4th Quarter 2005 monitoring session was 0.12 Wēkiu bugs per trap per 3 days of sampling. This rate is about half of the highest average capture rate measured on Pu'u Wēkiu during a 4th Quarter baseline monitoring session (0.2 WB 2002), and twice the rate measured during the 4th Quarter 2004.

Fifty-four percent (26 of 48) of the Wēkiu bugs captured in the 4th 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.

About 2% (1 of 48) of the Wēkiu bugs captured during the 4th Quarter 2005 sampling session died in live-traps. The improvements to the special live-traps appear to have reduced trap-caused mortality.

Other Observations

During the 4th 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.



**Covered trash container used to remove trash from the W. M. Keck Observatory.
Photo taken October 14, 2005.**

Trash containers with locking lids are used to remove trash from the WMKO. Upon inspection the container and truck used for hauling were found to have been recently pressured washed, and were free of dirt and alien arthropods.

