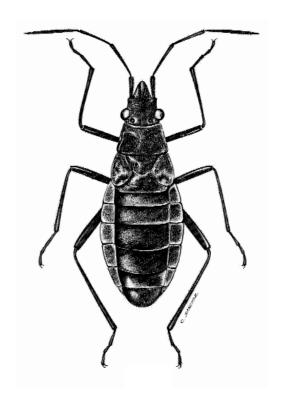
WĒKIU BUG BASELINE MONITORING

2nd QUARTER 2002 QUARTERLY REPORT



Revised April 2004



Pacific Analytics, L.L.C.



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2nd QUARTER 2002 QUARTERLY REPORT

Prepared for

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

Revised April 2004



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Wēkiu Bug Baseline Monitoring TABLE OF CONTENTS

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2nd QUARTER 2002 QUARTERLY REPORT

I. **TABLE OF CONTENTS**

		Page
I.	TABLE OF CONTENTS	1
II.	EXECUTIVE SUMMARY	3
III.	INTRODUCTION	5
IV.	QUESTIONS OF INTEREST	7
V.	METHODS	9
VI.	RESULTS	13
VII.	DISCUSSION	31

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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. 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.

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 Wekiu Bug Mitigation Plan and Wēkiu Bug Monitoring Plan. They are also the participants in this Wēkiu Bug Baseline Monitoring Plan.

Sampling of Wekiu bug habitat was approved to establish baseline population estimates of the Wekiu bug in the area surrounding the site of the proposed Outrigger Telescopes Project and at a control site on Pu'u Wēkiu. The 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 (QOI's). They are:

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

Wēkiu Bug Baseline Monitoring EXECUTIVE SUMMARY

Nondestructive sampling is the best approach 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 livetraps 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. During this sampling session a total of 35 Wēkiu bugs appeared in or near the traps. 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 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. This is about three times greater than the average trap capture rate measured on Pu'u Hau 'Oki during the entire 1997/98 Arthropod Assessment (0.38 Wēkiu Bugs per trap per 3 days of sampling). The Wēkiu bug population apparently has increased since 1998.

The second quarter three-week sampling session was conducted from April 29, 2002 through May 24, 2002. During this sampling session a total of 359 Wēkiu bugs appeared in or near the traps. The capture rate during the second quarter session ranged from 0 to 38.8 Wēkiu bugs per trap per 3 days of sampling. All but one of the 360 Wēkiu bugs captured were collected from Pu'u Hau 'Oki.

The average trap capture rate on Pu'u Hau 'Oki in May 2002 was 9.56 (±5.19) Wēkiu bugs per trap per 3 days of sampling. This rate is about ten times greater than the average capture rate measured on Pu'u Hau 'Oki during the first quarter baseline monitoring session, and more than fifty times greater than the average capture rate (0.20 Wēkiu bugs per trap per 3 days of sampling) measured in the same area during a comparable period of the 1997/98 Arthropod Assessment (Howarth et al. 1999). Wēkiu bug activity on Pu'u Hau 'Oki has increased since February 2002, and the Wēkiu bug population has evidently increased since April 1998.

This report represents a presentation of the May 2002 Baseline Wēkiu bug monitoring results.

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 Wekiu 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 Wekiu Bug Mitigation Plan and Wēkiu Bug Monitoring Plan. They are also the participants in this Wekiu Bug Baseline Monitoring Plan.

Sampling of Wekiu bug habitat was approved establish baseline to population estimates of the Wekiu bug in the area surrounding the site of the proposed Outrigger Telescopes Project and at a control site on Pu'u Wēkiu. The populations of Wekiu bugs were last measured at these sites in 1998 during an arthropod assessment conducted of the as part Environmental **Impact** Statement prepared for the Mauna Kea Master Plan approved in 2000 by the UH Board of Regents. This new monitoring activity will update that 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.

Wēkiu Bug Baseline Monitoring INTRODUCTION

This is the second Quarterly Report of Baseline Monitoring. The results of the sampling effort conducted April 29 28 through May 24 are reported. Comparisons to previously collected data will be presented, along with new interpretations analysis and correlations of changes in Wekiu bug populations with weather related phenomena.



Pu'u Ala, Pu'u Makanaka, and Pu'u Poepoe viewed from Pu'u Mahoe. Wēkiu bugs have been found on Pu'u Makanaka and other cinder cones near the summit of Mauna Kea.

Wēkiu Bug Baseline Monitoring QUESTIONS OF INTEREST

QUESTIONS OF INTEREST IV.

Important Questions of Interest (QI's) 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 Wekiu bug populations changing? Locations of interest include current habitat on Pu'u Hau 'Oki crater and undisturbed Wēkiu bug habitat at Pu'u Wēkiu on the Mauna Kea summit area (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:

- To provide historical records of change in Wekiu 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 Wekiu Bug population change. Monitoring these indirect factors will aid in understanding trends in Wekiu Bug population change.

Monitoring goals:

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



Cinder Stockpile near the James Clerk Maxwell Telescope. Cinder from this stockpile is used for road maintenance, and is being considered for Wekiu bug habitat restoration. Pu'u Poli'ahu is in the background.

Wēkiu Bug Baseline Monitoring METHODS

\mathbf{V} . **METHODS**

Live Traps

Nondestructive sampling is the best approach to monitoring rare and sensitive invertebrate species. Data on relative abundance can be collected with specially designed live-traps that cause minimal disturbance to Wekiu bugs or their habitats. Non-destructive live-traps 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 can sustain captured individuals several days.

Ten live-traps were set at the same locations where traps were installed during the previous sampling session, five on Pu'u Hau Oki and five on Pu'u Wēkiu.

Protocol for Setting Live-Traps

The habitat sampled 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 Wekiu bugs to easily walk into the traps.

Traps were set by placing reservoir cups into the wire tubes and pouring about 15 ml of purified water into the reservoir (Step 4). About a teaspoon of shrimp paste was spread on the coffee filter wick in the trap cups and two to three pieces of re-hydrated shrimp were added to each cup (Step 5). Four to five pieces of native cinder, ½" to 1" in diameter were added and the trap cups were placed into the reservoir cups such that the coffee-filter wicks made contact with the water reservoirs (Step 6).

Chum, consisting of pureed premoistened shrimp, was distributed around the traps and a teaspoon of shrimp paste was spread on the bottom of the cap rocks (Step 7). Irrigation flags to mark the locations

Wēkiu Bug Baseline Monitoring METHODS

were wrapped around cap rocks, ten to fifteen inches in diameter. The cap rocks were then placed over each trap such that the entire trap was shaded from sunlight (Step 8).

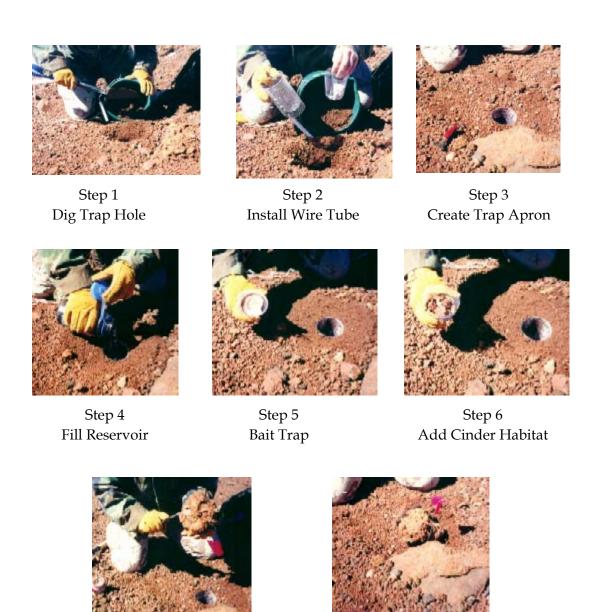
Traps were checked for Wēkiu bugs every three days during the sampling session. During each live-trap check, an area about 20 cm in diameter around the live-trap was checked for the presence Wēkiu bugs. The trap cups were then removed and carefully inspected for Wēkiu bugs. Live Wēkiu bugs were counted and released to cinder habitat at least 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, trap 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.

Modifications to the live-traps were investigated to increase Wēkiu bug survival. Rain and snow fell during some of the 3-day sampling periods, causing moisture to accumulate in the trap cups. Drain holes in the cups designed to draw off excess moisture did not prevent saturation of the filter wick and drowning of some Wēkiu During some of the 3-day bugs. sampling periods a few of the reservoirs were left dry. Wēkiu bug survival increased in these cups. It is recommended during that weather, reservoir cups should not be filled and cinder habitat in the trap cups should be placed under the filter wick to provide dry shelter for Wēkiu bugs.

Wēkiu Bug Baseline Monitoring METHODS

Setting a Wēkiu Bug Live-Trap



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 was downloaded from the World Wide Web at www.maunakeaweather.hawaii.edu. The UKIRT Observatory is located on Pu'u Kea, and is adjacent to the Pu'u Wēkiu sampling sites, and is less than one-half mile away from the Pu'u Hau 'Oki sampling sites.

Average temperature, average windchill temperature, average barometric pressure, and average humidity were calculated for each 3-day sampling session from the UKIRT Observatory weather data. Minimum and maximum temperatures for the 3-day sampling sessions were also noted from the data.

Archive photographs were taken from fixed points on Pu'u Hau 'Oki and on Pu'u Wēkiu. Photographs were taken at the beginning of each sampling period to record snow coverage and changes in Wēkiu bug habitats through time.



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.

VI. RESULTS

There were a total of twenty-four sampling nights, making eight 3-day sampling periods. There was no data from one of the sampling periods because weather prevented access to the traps. A total of three hundred and sixty Wēkiu bugs were captured, three hundred and fifty-nine on Pu'u Hau 'Oki and one on Pu'u Wēkiu. The trap capture rate (number of Wēkiu bugs per trap per 3-days) ranged from

zero to 38.8 Wēkiu bugs. The overall trap capture rate during the 3-week sampling session was 9.56 (±5.19) Wēkiu bugs for Pu'u Hau 'Oki, and 0.03 (±0.03) Wēkiu bugs for Pu'u Wēkiu (Table 1). For comparison, average trap capture rates for the 1st Quarter 2002 and the 1997/98 Arthropod Assessment are provided (Table 2 and Table 3).

TABLE 1. MAY SAMPLING PERIOD AVERAGE TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each 3-day sampling period for 2nd Quarter 2002 Baseline Monitoring.

	5/2/02	5/8/02	5/11/02	5/15/02	5/18/02	5/22/02	5/24/02
Pu'u Wekiu	0.00	0.00	0.00	0.00	0.20	0.00	0.00
Pu'u Hau Oki	1.20	0.60	4.80	14.70	4.60	2.20	38.80

TABLE 2. FEBRUARY SAMPLING PERIOD AVERAGE TRAP CAPTURE RATES

The average number of Wēkiu bugs per trap per 3-days for each 3-day sampling period for 1st Quarter 2002 Baseline Monitoring.

	2/4/02	2/7/02	2/10/02	2/13/02	2/16/02	2/19/02	2/22/02
Pu'u Wekiu	0.00	0.00	0.00	0.20	0.00	0.00	0.00
Pu'u Hau Oki	0.00	0.75	1.00	0.00	2.20	2.40	0.60

Wēkiu Bug Baseline Monitoring RESULTS

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 and 2002 Baseline Monitoring. Average trap capture rates for the 1997/98 Arthropod Assessment and 2002 Baseline Monitoring are in RED.

	Aug. 1997	Jan. 1998	April 1998	July 1998	Avg. 1997/98	Feb. 2002	May 2002	Avg. 2002
Pu'u Wekiu	0.15	0.00	0.07	0.15	0.11	0.03 (±0.03)	0.03 (±0.03)	0.03 (±0.00)
Pu'u Hau Oki	0.20	0.00	0.20	1.10	0.38	0.99 (±0.37)	9.56 (±5.19)	5.28 (±4.28)

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TABLE 4. MAY 2002 WĒKIU BUG TRAP CAPTURE DATA

	5/2/02		5/8/02		5/11/02		5/15/02	
	adult WB	juvenile WB	adult WB	juvenile WB	adult WB	juvenile WB	adult WB	juvenile WB
Pu'u Wekiu								
Trap 1	0	0	0	0	0	0	0	0
Trap 2	0	0	0	0	0	0	0	0
Trap 3	0	0	0	0	0	0	0	0
Trap 4	0	0	0	0	0	0	0	0
Trap 5	0	0	0	0	0	0	0	0
Pu'u Hau Oki								
Trap 1	5	0	0	0	2	2	18	0
Trap 2	1	0	0	0	5	1	17	0
Trap 3	0	0	0	0	1	0	5	0
Trap 4	0	0	0	1	4	0	22	0
Trap 5	0	0	2	0	9	0	36	0
	5/18/02		5/21/02		5/24/02		SUM	
	5/1	18/02	5/2	21/02	5/2	24/02	S	UM
						juvenile WB		
Pu'u Wekiu								
Pu'u Wekiu Trap 1								
	adult WB	juvenile WB	adult WB	juvenile WB	adult WB	juvenile WB	adult WB	juvenile WB
Trap 1	adult WB	juvenile WB	adult WB	juvenile WB	adult WB	juvenile WB	adult WB	juvenile WB
Trap 1 Trap 2	adult WB 0 0	juvenile WB 0 0	adult WB 0 0	juvenile WB 0 0	adult WB 0 0	juvenile WB 0 0	adult WB 0 0	juvenile WB 0 0
Trap 1 Trap 2 Trap 3	0 0 1	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 1	0 0 0
Trap 1 Trap 2 Trap 3 Trap 4	0 0 1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1	0 0 0
Trap 1 Trap 2 Trap 3 Trap 4	0 0 1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1	0 0 0
Trap 1 Trap 2 Trap 3 Trap 4 Trap 5	0 0 1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 1	0 0 0
Trap 1 Trap 2 Trap 3 Trap 4 Trap 5 Pu'u Hau Oki	0 0 1 0 0	0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 1 0	0 0 0 0 0
Trap 1 Trap 2 Trap 3 Trap 4 Trap 5 Pu'u Hau Oki Trap 1	0 0 1 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0	0 0 1 0 0	0 0 0 0 0
Trap 1 Trap 2 Trap 3 Trap 4 Trap 5 Pu'u Hau Oki Trap 1 Trap 2	0 0 1 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 1 0 0 0	0 0 0 0 0 0

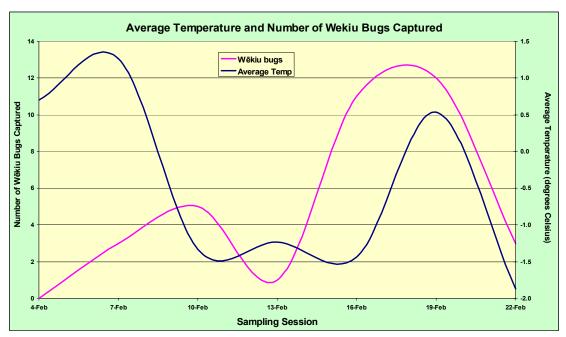


FIGURE 1. Plot of Average Temperature and Total Wēkiu Bug Captured for Seven Sampling Periods in 1st Quarter 2002.

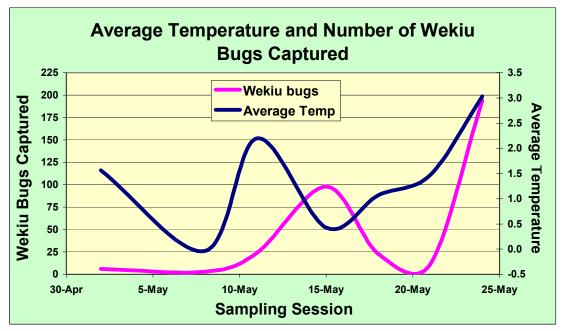


FIGURE 2. Plot of Average Temperature and Total Wēkiu Bug Captured for Seven Sampling Periods in 2nd Quarter 2002.

Pu'u Hau 'Oki Inner Slope Photographic Archive

FEBRUARY 2002



Pu'u Hau 'Oki inner slope February 10, 2002



Pu'u Hau 'Oki inner slope February 13, 2002



Pu'u Hau 'Oki inner slope February 16, 2002

MAY 2002



Pu'u Hau 'Oki inner slope May 02, 2002



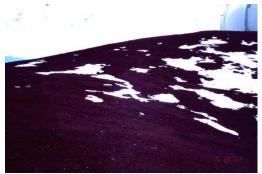
Pu'u Hau 'Oki inner slope May 08, 2002



Pu'u Hau 'Oki inner slope May 11, 2002



Pu'u Hau 'Oki inner slope May 15, 2002



Pu'u Hau 'Oki inner slope May 18, 2002



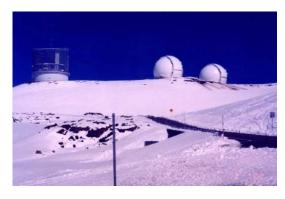
Pu'u Hau 'Oki inner slope May 21, 2002



Pu'u Hau 'Oki inner slope May 24, 2002

Pu'u Hau 'Oki Outer Slope Photographic Archive

FEBRUARY 2002



Pu'u Hau 'Oki outer slope February 07, 2002



Pu'u Hau 'Oki outer slope February 10, 2002



Pu'u Hau 'Oki outer slope February 13, 2002



Pu'u Hau 'Oki outer slope February 16, 2002



Pu'u Hau 'Oki outer slope February 22, 2002

MAY 2002



Pu'u Hau 'Oki outer slope May 02, 2002



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



Pu'u Hau 'Oki outer slope May 15, 2002



Pu'u Hau 'Oki outer slope May 18, 2002



Pu'u Hau 'Oki outer slope May 21, 2002



Pu'u Hau 'Oki outer slope May 24, 2002

Pu'u Wēkiu Photographic Archive

FEBRUARY 2002



Pu'u Wēkiu inner slope February 04, 2002



Pu'u Wēkiu inner slope February 10, 2002



Pu'u Wēkiu inner slope February 13, 2002



Pu'u Wēkiu inner slope February 16, 2002



Pu'u Wēkiu inner slope February 22, 2002

MAY 2002



Pu'u Wēkiu inner slope May 02, 2002



Pu'u Wēkiu inner slope May 08, 2002



Pu'u Wēkiu inner slope May 11, 2002



Pu'u Wēkiu inner slope May 15, 2002



Pu'u Wēkiu inner slope May 18, 2002



Pu'u Wēkiu inner slope May 21, 2002

Wēkiu Bug Baseline Monitoring RESULTS



Pu'u Wēkiu inner slope May 24, 2002

Pu'u Wēkiu and Hau Kea Photographic Archive

FEBRUARY 2002



Pu'u Wēkiu and Hau Kea February 01, 2002



Pu'u Wēkiu and Hau Kea February 07, 2002



Pu'u Wēkiu and Hau Kea February 10, 2002



Pu'u Wēkiu and Hau Kea February 13, 2002



Pu'u Wēkiu and Hau Kea February 16, 2002



Pu'u Wēkiu and Hau Kea February 22, 2002

MAY 2002



Pu'u Wēkiu and Hau Kea May 02, 2002



Pu'u Wēkiu and Hau Kea May 08, 2002



Pu'u Wēkiu and Hau Kea May 11, 2002



Pu'u Wēkiu and Hau Kea May 15, 2002



Pu'u Wēkiu and Hau Kea May 18, 2002



Pu'u Wēkiu and Hau Kea May 21, 2002

Wēkiu Bug Baseline Monitoring RESULTS



Pu'u Wēkiu and Hau Kea May 24, 2002

Wēkiu Bug Baseline Monitoring DISCUSSION

VII. DISCUSSION

Trapping Data

Permission to begin Baseline Wēkiu bug Monitoring was received on January 21, 2002. On January 28, Pacific Analytics personnel installed 10 live-traps in designated areas, five on the inner slopes of Pu'u Hau 'Oki and five on the slopes of Pu'u Wēkiu. 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 (7 samples per trap).

Several Wēkiu bugs appeared in the traps and a large proportion of them survived to be released. During the 3-week sampling session a total of three hundred and fifty-nine Wēkiu bugs appeared in or near the traps. That represents a ten-fold increase over trap captures in February 2002. All of the Wēkiu bugs that were captured appeared in live-traps on Pu'u Hau 'Oki. None appeared in live-traps on Pu'u Wēkiu. All live bugs were released back into their habitat.

During the 1997/98 Mauna Kea Science Reserve (MKSR) Arthropod Assessment (Howarth et al. 1999) 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 Pu'u Hau 'Oki during the May 2002 Baseline Monitoring session ranged from 0 to 38.8 Wēkiu bugs per trap per 3-days (Table 1). In February 2002 the trap capture rate ranged from 0 to 2.4, and during the 1997/98 MKSR Arthropod Assessment, trap capture rates on Pu'u Hau 'Oki ranged from 0 to 1.1 Wēkiu bugs (Table 2).

The average trap capture rate in Pu'u Hau 'Oki was 9.56 Wēkiu bugs per trap per 3 days of sampling (Table 3). This is about twenty-seven times greater than the average trap capture rate measured on Pu'u Hau 'Oki during the 1997/98 Arthropod Assessment (0.38 Wēkiu bugs per trap per 3 days of sampling) (Table 3), and about ten times greater than in February 2002. It appears that Wekiu bug populations may be increasing on Pu'u Hau 'Oki, and that Wēkiu bugs

Wēkiu Bug Baseline Monitoring DISCUSSION

were more active in May 2002 than in February 2002.

The average trap capture rate on Pu'u Wēkiu was 0.03 Wēkiu bugs per trap per 3 days of sampling (Table 3). This is the same rate measured in February 2002. During the 1997/98 study the rate was 0.11 Wēkiu bugs per trap per 3 days of sampling (Table 3). Evidently Wēkiu bug activity has not changed since either February 2002 or 1997/98, and the population has seemingly remained stable on Pu'u Wēkiu.

It was noted during the February 2002 Baseline Monitoring that the cinder slopes of Pu'u Wēkiu remained frozen longer than those on Pu'u Hau 'Oki. Snow persisted longer on Pu'u Wēkiu as well (see Photographic Archive above). It is possible that the snow and frozen cinder hindered Wēkiu bug activity and that once the cinder Wēkiu bug activity may increase. However, snow coverage in May 2002 was less than in February and Wekiu bug activity did not change on Pu'u Wēkiu. More information will have to be gathered better to understand this issue.

While the average Baseline Monitoring trap capture rate is high compared to the 1997/98 Arthropod Assessment, it is only about one tenth of the trap capture rate measured during the 1982

Arthropod Assessment (105.61 Wēkiu bugs per trap per 3 days of sampling). Populations have not yet returned to former highs, but careful management will help to ensure future survival of the Wēkiu bug.

The Wekiu bug population has apparently increased since 1998. The number of Wēkiu bugs captured during the 3-week sampling session (359 Wēkiu bugs in seventy 3-day trap periods) was more than 12 times the number collected during the five oneweek sampling sessions over 18 months of sampling for the 1997/98 Arthropod Assessment (30 Wēkiu bugs in one hundred fifty-six 3-day trap periods) on Pu'u Hau 'Oki and Pu'u Wēkiu. Several Wēkiu bugs were observed under rocks and in cinder along the slope break and inner slopes of Pu'u Hau 'Oki during the May 2002 sampling session, a rare event during the 1997/98 Arthropod Assessment.

Recent snow events have deposited significantly more snow on Mauna Kea than occurred during the 1997/98 assessment. It has been hypothesized that Wēkiu bugs may be responding to the larger snow events of the last two years, or other environmental phenomena, and increasing their populations. The true cause of their decline and apparent recent recovery currently remains unknown.

Wēkiu Bug Baseline Monitoring DISCUSSION

Weather Data

The number of Wekiu bugs captured in live-traps appears to vary with average air temperature (Figure 1 and Figure 2). The highest trap captures occurred when average temperature was higher than one degree centigrade, and lowest when average air temperature was lower than below zero degrees centigrade. More information will need to be collected before conclusive inferences can be made about Wēkiu response to changes in temperature, however the information gathered during the February and May 2002 sampling sessions is consistent with the hypothesis that Wēkiu bug activity may be regulated temperature.

Other Observations

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

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



DEIMOS camera tractor and trailer at the WMKO site.

The tractor and trailer were pressurewashed 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.

On May 15, 2002 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.

The WMKO site was free of loose trash. A pickup truck was observed

Wēkiu Bug Baseline Monitoring DISCUSSION

transporting a covered trash container to the WMKO. 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.



Pickup transporting a trash container.

The deep snow that accumulated during January and February attracted many people to the summit for snow play. During February 2002 visitors were observed from Pu'u Hau Kea and other lower cinder cones all the way to the summit on Pu'u Wēkiu. Snow play was observed on slopes where Wēkiu bug habitat is known to exist.

In May 2002, snow fall was less frequent and less intense than in February 2002. Snow play was observed only once during the May 2002 sampling session. The impacts on Wēkiu bugs due to snow play on the Mauna Kea summit cones are unknown.

Other Events

April 2002 - Wēkiu bug survey

The US Fish and Wildlife Service, the Smithsonian Institution, and the B.P. Bishop Museum conducted a survey to determine the extent of Wēkiu bug distribution on Mauna Kea. That information and the information from Baseline Monitoring will be given to the Office of Mauna Kea Management to be used in natural resource management planning for the MKSR.