IV. HABITAT RESTORATION AND PROTECTION

Analysis of Potential Impacts

The summit ridge of Mauna Kea is made up of three cinder cones, Puʻu Hau ʻOki, Puʻu Wēkiu, and Puʻu Kea. Hawaiian cinder cones form during the later stages of volcanism (Hazlett and Hyndman 1996), and the summit area cones are thought to be 14,000 to 65,000 years old (Wolf and Morris 1996).

Hawaiian cinder cones have typically developed during single eruptions lasting weeks or months (Hazlett and Hyndman 1996). The steam-filled, explosive eruptions deposit ash and chunks of magma (cinders) varying in size from sand to large blocks, quickly building symmetrical cones up to a thousand feet tall. As the eruptions subside, cup-like craters form inside of the cones. Occasionally, lava flowing from the vent may displace part of the cone, leaving a horseshoe-shaped crater rim. Puʻu Hau ʻOki, upon which rest the W. M. Keck and Subaru Observatories, is a horseshoe shaped crater with its opening facing north-northwest. Glacial movement during the late Ice Ages also contributed to the present shape of Puʻu Hau ʻOki.

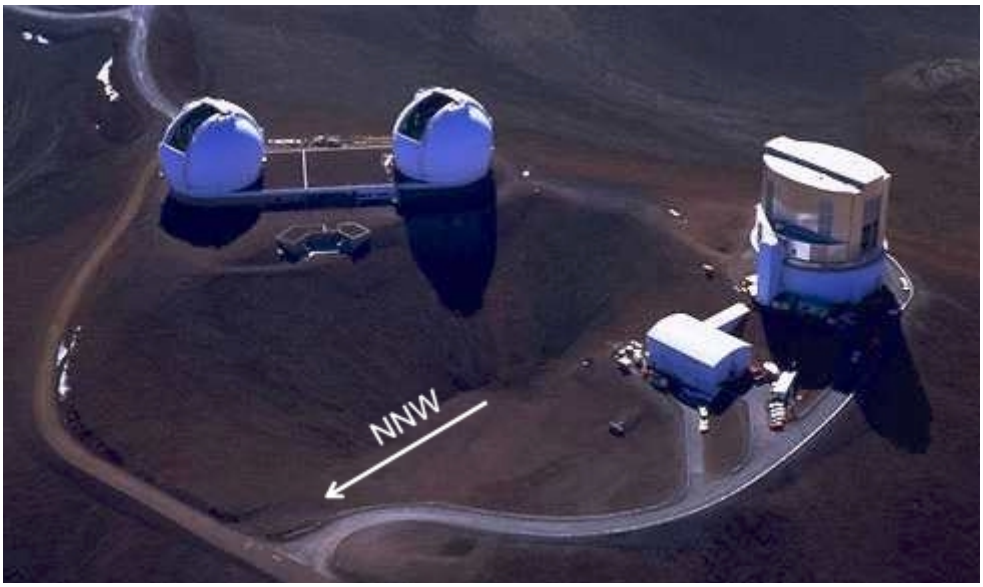

Figure IV-1. Puʻu Hau ʻOki crater, with the twin domes of Keck I and II to the left and the Subaru Observatory to the right. *Photo courtesy W. M. Keck Observatory.*

The cinder cones are made up of a mixture of ash and rocks of many sizes. In the alpine environment of Mauna Kea's summit, ice, frost heaving, and snowmelt have worked to wash and stratify the surface layer of the cones. Progressively larger rocks have been lifted to the surface and washed clean of ash, which in turn has accumulated in a layer 12 to 18 inches below the surface.

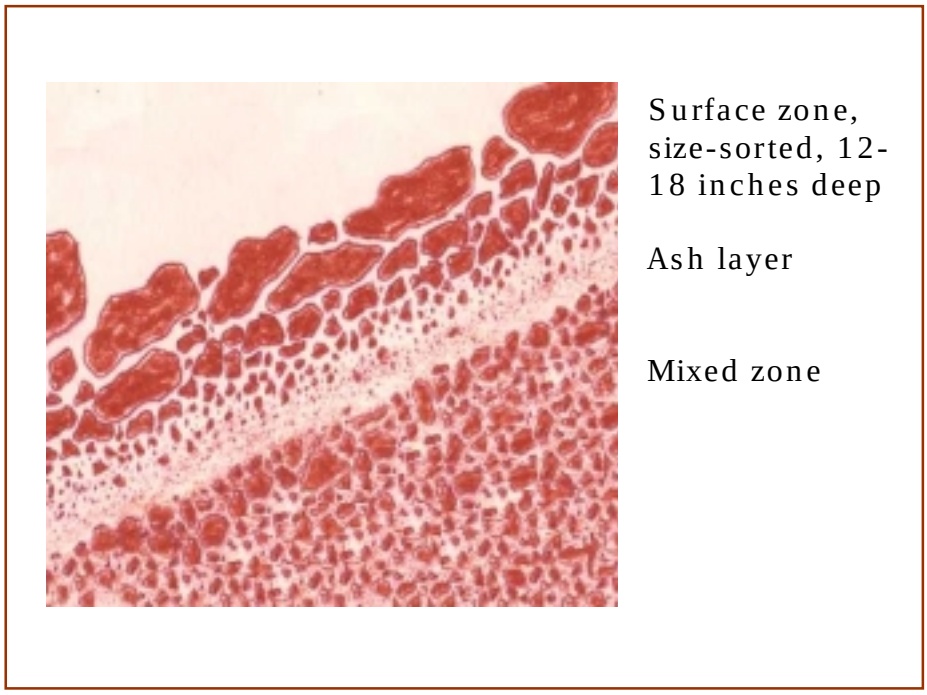

Figure IV-2. Schematic cross-section of the slope surface showing the stratification (size-sorting) and washing of the surface cinder by the actions of ice, frost heaving, and snowmelt.

The sorting and washing of the surface cinder leads to the development of interstitial spaces, or voids between the rocks. Researchers hypothesize that Wēkiu bugs live in these voids in the surface layer.

Autecology is the study of the patterns of distribution and abundance of individual species, together with the ecosystem structure and functions that influence distribution and abundance. The autecology of the Wēkiu bug is not well understood. Wēkiu bugs are rare, small, nocturnal, and live in a remote and harsh environment. These factors have made

autecological studies difficult. Nevertheless, hypotheses have been developed that seek to explain Wēkiu bug autecology.

Currently, Wēkiu bug researchers generally accept the "habitat structure" hypothesis (Howarth et al. 1999); observational evidence is supportive, (and contrary evidence is absent). Wēkiu bugs appear to utilize the voids in the surface layer of cinder as hiding spaces, thermal cover, and passageways for movement. Wēkiu bugs have not been found in or below the ash layer. They are not burrowing insects, and are not thought to be able to penetrate either the ash layer or the compacted ash/cinder mix at deeper levels. Thus, Wēkiu bug habitat is thought to be limited to the 12 to 18 inches of washed and size-sorted rock on the surface of the Mauna Kea summit cinder cones (Howarth et al. 1999).

While this habitat, and its porous structure, is fairly stable, it is possible that slope disturbance can degrade it. Excessive side-casting of unsorted materials can bury Wēkiu bug habitat and the resident population. Because Wēkiu bugs are not burrowing insects, they are not thought to be resilient to excessive burial or habitat compaction.

Past studies have found that the inner crater walls of Puʻu Hau ʻOki have the densest population of Wēkiu bugs of any site on the Mauna Kea summit (Howarth et al. 1999). In 1982 the entire crater harbored Wēkiu bugs (Howarth and Stone 1982), but the subsequent construction of the WMKO and the Subaru Observatory filled or buried about one-third of the within-crater habitat.

The (relatively) undisturbed, west and northwest facing, within-crater slopes below the WMKO complex remain the best-used habitat of Wēkiu bugs. No Wēkiu bugs were found on slopes adjacent to Subaru during a preliminary survey prior to the 1997-98 study (Howarth et al. 1999). The researchers decided not to trap on slopes adjacent to Subaru after consideration of preliminary findings, and after observation of the markedly different surface structure of these slopes compared to other known occupied habitats (Howarth et al. 1999, Map 2). The slopes adjacent to Subaru are beginning to show signs of surface washing and early development of a shallow ash layer. Size-sorting of surface rocks is not yet evident. Wēkiu bugs may return to these slopes in time, but only if the within-crater population survives until the preferred habitat structure develops. The slopes adjacent to the older WMKO also received significant side-cast overburden. The surface structure on those slopes has recovered to some degree, and currently provides habitat to the densest population of Wēkiu bugs measured during the 1997/98 Mauna Kea arthropod assessment (Howarth et al. 1999).

It is important to preserve the remaining habitat structure in Puʻu Hau ʻOki, and thereby retain a viable Wēkiu bug population in the crater. The graded and compacted crater floor of Puʻu Hau ʻOki may be the best possible location for Wēkiu bug habitat restoration. Habitat restoration, slope stability controls, and protection from excessive surface disturbance are thus crucial considerations in planning new construction and activities on the Puʻu Hau ʻOki crater rim, floor, and slopes.

Habitat Protection and Slope Stability Control Recommendations

The following recommendations are given to restore habitat, and to prevent and mitigate impacts to the slopes below the WMKO complex during construction and operation of the proposed Outrigger Telescopes. Our intention and hope is that Wēkiu bug populations will actually **increase**, due to protection and restoration of potentially favorable habitat.

Recommendation IV-1: Wēkiu bug habitat should be restored in areas damaged by on-site Outrigger Telescope construction, and in the crater floor of Puʻu Hau ʻOki. Restored areas should total at least three times the total area damaged by new construction.

Restoration habitat should be composed of screened cinder larger than ½ inch, washed with water to remove ash. Cinder should be spread 12 to 18 inches deep in the restoration areas, and should form a complete interface with cinder in adjacent Wēkiu bug habitat. It may be necessary that cinder be spread more than 18 inches deep in some places, in order to assure the necessary contact with existing habitat.

Areas damaged by new construction should be restored to the extent possible. This will not be possible in areas where new construction covers existing Wēkiu bug habitat with concrete foundations of junction boxes, air pipes, light tunnels, and retaining walls. Restoration of habitat of an area at least three times the area newly damaged will aid in enhancing the Wēkiu bug population in the crater. Restoration of the entire crater floor, an area of approximately one acre, would be desirable if sufficient quantities of appropriately sized cinder are available.

Screened and washed cinder may be emplaced on the crater floor by partial tilting of the dump bed while the truck is slowly moving. No further working of the screened cinder is required; uneven deposition will make better habitat than an evenly spread or compacted surface. No preparation of the crater floor prior to deposition is required.

The non-permanent barrier blocking vehicle access to the crater floor should be removed to allow transport of the screened cinder into the crater floor. The barrier should be replaced after installation of the restored habitat.

The restored habitat should be monitored to measure the rate of occupation by Wēkiu bugs, (see Section IX, Monitoring).

Attractive, non-intrusive, educational signs should be installed near the crater access point along the adjacent service road, (see Recommendation IV-3). The signs should have information about Wēkiu bugs and their habitat. Signs will help prevent unintentional disturbance of habitat by visitors to the summit.

Recommendation IV-2: Under no circumstances should cinder or other materials be side-cast into Wēkiu bug habitat. Temporary, and if possible, permanent barriers should be built along the slope breaks above the inner slopes of Pu‘u Hau ‘Oki crater.

Excavated cinder, construction materials, trash, or other substances deposited on the inner slopes of Pu‘u Hau ‘Oki crater could impact Wēkiu bug habitat. Barriers will reduce risk of accidents to people and disturbance to the Wēkiu bug habitat mitigation structures below. Temporary barriers should be constructed along the slope break prior to any construction activities. These barriers should be firmly affixed to withstand the 100 mile-per-hour winds that occasionally blow across the summit area.

There are many options for permanent barriers. The following five options are suggested for consideration:

1. Habitat mitigation barriers. These could be cinder-filled blocks with textured faces, color-matched to the cinder slopes. This type of barrier should extend vertically about 40 inches above the finished grade. This option would also provide additional mitigation habitat for Wēkiu bugs.

2. Chain link fence barriers. These would be effective at preventing wind-blown trash from going over the slope break, and also discourage people from climbing out onto Wēkiu bug habitat.

3. Guard rails. These are found elsewhere on the summit, and would be effective at blocking vehicles from going over the edge.

4. Post-and-chain barriers. These would provide a psychological barrier to climbers.

5. Cautionary signs only. These would provide a psychological barrier to climbers.

Recommendation IV-3: Educational signs should be placed along the slope break above Wēkiu bug habitat, and at the service road adjacent to the crater floor.

Many places along the leveled WMKO site edge provide special scenic vistas. There are foreground views into the Puʻu Hau ʻOki crater, midground views of the summit area, and background views of the entire Island and beyond. These vistas are unique and among the reasons people visit the summit.

Attractive, non-intrusive, educational signs should be installed to inform people about Wēkiu bugs and their habitat. Signs will help prevent unintentional disturbance of habitat by workers and visitors.

Skiers may disturb the hypothesized ecological functions of the snow pack in Puʻu Hau ʻOki crater. They may also damage the cinder surface structure beneath the snow. There are other places on the Mauna Kea summit that have fewer Wēkiu bugs and equivalent snow. It will be recommended to UH that skiers should be directed to those other places. Educational signage will aid this.

Recommendation IV-4: The WMKO staff should continue current practices for dealing with on-site deep snow events.

The potential exists for graded snow to accumulate on the edge of roads and parking areas above habitat slopes. The amount of snow accumulation is affected by weather events. When deep snow events occur, large amounts of graded snow may accumulate as a result of clearing roads and parking areas. Current practices for dealing with deep snow events are:

1) Use of a snow blower, when conditions permit, to remove snow from roads and parking areas. Snow is blown over the edge onto adjacent slopes and has little impact on slope

stability and habitat structure. Snow blowing is not always an option on Mauna Kea because an icy crust develops quickly on the snow there. Snow melted during the warm days turns to ice at night when temperatures regularly fall below freezing.

2) Use of a snowplow and grader as needed to remove snow from roads and parking areas. Equipment operators are careful not to scrape the cinder surface of roads and parking areas, and purposely leave a thin layer of snow or ice. Accumulated graded snow is largely free of cinder and ash.

Accumulated graded snow accidentally pushed onto adjacent slopes has not been observed to have an impact on slope stability and habitat structure, and probably does not disturb Wēkiu bug populations.