CANDIDATE ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Nysius wekiuicola*

COMMON NAME: Wekiu bug

LEAD REGION: Region 1

INFORMATION CURRENT AS OF: April 2004

STATUS/ACTION (Check all that apply):
___ New candidate
_X_ Continuing candidate
___Non-petitioned
__X_ Petitioned - Date petition received: _May 29, 2003__
___ 90-day positive - FR date: ___
__ 12-month warranted but precluded - FR date: ___
___ Is the petition requesting a reclassification of a listed species?
___ Listing priority change
Former LP: ___
New LP: ___
Latest date species first became a Candidate: October 25, 1999_____
___ Candidate removal: Former LP: ___ (Check only one reason)
___ A - Taxon more abundant or widespread than previously believed or not subject to a degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
___ F - Range is no longer a U.S. territory.
___ M - Taxon mistakenly included in past notice of review.
___ N - Taxon may not meet the Act's definition of "species."
___ X - Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Lygaeidae (seed bugs)

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, island of Hawaii

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, island of Hawaii

LEAD REGION CONTACT (Name, phone number): Scott McCarthy (503/231-6131)

LEAD FIELD OFFICE CONTACT (Office, name, phone number): Pacific Islands Office, Mike Richardson (808/792-9448)

BIOLOGICAL INFORMATION:

The island of Hawaii today consists of five volcanic mountains. All are very young and three have been active in recent history (MacDonald *et al*. 1983). Mauna Kea is the highest of these volcanoes, rising 4,206 meters (m) (13,796 feet (ft)) above sea level. The surface lavas of this volcano are all younger than middle Pleistocene, and it has probably not been active during the last 2,000 years. During the Pleistocene epoch an ice cap existed on the summit of Mauna Kea, with at least four distinct glacial episodes during the last 300,000 years (Porter 1979). The most recent glacial event (the Makanapa ice cap) disappeared from Mauna Kea about 9,000 years ago, but permanent ice still exists in the cinder of the summit cones just a few feet below the surface (Woodcock 1974; KAHEA: The Hawaiian-Environmental Alliance (KAHEA) 2003).0

Presently, the summit of Mauna Kea above 3,000 m (9,843 ft) is an alpine lava community sparsely vegetated with growths of foliose lichens and the moss, *Racometrium lanuginosum* (Gagne and Cuddihy 1990). Prior to the 1980s, due to an apparent lack of vegetation, it was popularly believed the Mauna Kea summit was a lifeless alpine desert. One well-known astronomist was even quoted as saying "(the summit) is a lifeless, red-black jumble of lava blocks (Waldrop 1981). However, in 1979 with the discovery of the Wekiu bug (*Nysius Wekiuicola*), and subsequently into the early 1980s, a whole aeolian community of arthropods was discovered at the summit (Mull and Mull 1980; Papp 1981; Gagne and Howarth 1982). Aeolian ecosystems are characterized by a near lack of natural producers, a windborne supply of nutrient material, a few plants such as algae, mosses, and lichens, and by a community of mostly arthropod predators and scavengers evolved to feed on the windborne food supply. On Mauna Kea's summit, the major faunal components include a flightless moth whose caterpillars feed on the lichens, a *Lycosa* wolf spider, a centipede that preys on moribund insects blown to the summit, and the unique, flightless Wekiu bug (Howarth and Stone 1982).

At least six major habitat types can be recognized within this alpine ecosystem, and not all are suitable for each of the species (Howarth and Stone 1982): 1) Snow patches provide a moisture and food resource for all of the summit arthropods but are not directly utilized by any of the species; 2) tephra ridges and slopes on cinder cones are important habitat for the spider, the Wekiu bug, and smaller arthropods such as springtails; 3) loose, steep tephra slopes with smaller cinders are not suitable habitat for the Wekiu bug; 4) lava flows with large outcrops of andesitic rock are the primary habitat for the moth, the spider, and the centipede, but the Wekiu bug is rare in this habitat due to the lack of suitable microclimate; 5) talus slopes and fractured rock outcrops are typically smaller areas that occur within areas of andesitic lava flows and are suitable habitat for the Wekiu bug; and 6) compacted ash, silt, and mud along roadsides and in depressions (KAHEA 2003). Because the interstitial voids among the cinders are filled, the aeolian arthropods cannot utilize this habitat (Howarth and Stone 1982).

The Wekiu bug was first discovered in 1979 by F.G. Howarth, S.L. Montgomery, and W.P. Mull on Puu Wekiu, the summit cinder cone of Mauna Kea on the island of Hawaii (KAHEA 2003). Wekiu is a Hawaiian word meaning, "tip, top, topmost, summit," and the common name "Wekiu bug" was selected in reference to the insect's habitat (Ashlock and Gagne 1983; KAHEA 2003).

Lygaeidae is a family within the order of insects know as Hemiptera (true bugs). The family is characterized as a variable group, usually recognized by their four-segmented antennae, four-

segmented beak, ocelli (small eyes), and four or five simple veins in the membrane of the hemelytra (wings) (Borror *et al*. 1992; KAHEA 2003). Length varies from 2 to 18 millimeters (mm) (0.08 to 0.7 inches (in)) and many species are brightly marked with bands of black, white, or red (KAHEA 2003). Most members of this family are primarily seed feeders, earning the family nickname "seed bugs." Although the order Hemiptera contains many predators, including entire families of predators, (i.e. Reduviidae), Lygaeidae itself contains few predators (Borror *et al*. 1992). In Hawaii, the genus *Nysius* is characterized by the following physical attributes: conspicuous pubescence and erect setae (hairs) which clothe the greater part of the dorsal surfaces; the breadth of the head across the eyes is less than the narrowest breadth of the pronotum (the plate covering the thorax); and the hind margins of the metapleura (side of thorax) are concave with the postero-lateral angle rounded off (Zimmerman 1948; KAHEA 2003). Hawaiian *Nysius* also exhibit a wider range of characters than is exhibited worldwide by *Nysius* (KAHEA 2003). For example, the form of the bucculae (mouth), length of the beak, and shape of the costal margins are unreliable clues to identification (Zimmerman 1948). In Hawaii, *Nysius* has radiated into over 26 endemic species that feed on the seed heads of native plants (Polhemus 1998).

Adult Wekiu bugs are about 3.4 to 4.9 mm (0.13 to 0.19 in) in total length and 1.0 to 1.8 mm (0.039 to 0.07 in) in total width. The head is black, with pale reddish-brown median bars from the base of head to just short of the anterior eye margins. The pronotum is black, grayish-brown. The abdomen is black with pale lateral margins, and black legs (Ashlock and Gagne 1983; KAHEA 2003).

The Wekiu bug is a particularly unique component of the Mauna Kea aeolian ecosystem due to the evolution of its predatory habits. Excluding its close relative and Mauna Loa counterpart, *Nysius aa*, the Wekiu bug differs from all the world's *Nysius* species in its predatorial habits and unusual physical characteristics (Polhemus 1998). Furthermore, the bug is micropterous (possessing nearly microscopically small wings), has by far the longest, thinnest appendages in relation to body length of any Lygaeid in the world, and the most elongate head as well (KAHEA 2003). Wekiu bugs may be the most unusual of the 106 worldwide species of *Nysius* (Ashlock and Gagne 1983).

The Wekiu bug occupies a predator-scavenger niche on the top of Mauna Kea (KAHEA 2003). It is most often found under rocks and cinders where diurnally it preys upon moribund and dead insects and even birds blown up from lower elevations. The presence of high altitude arthropods on Mauna Kea has been known since the 1920s (Bryan 1923, 1926; Swezey and Williams 1932; Wentworth *et al*. 1935; Usinger 1936; Gagne 1971), but it wasn't until 1980 that the Wekiu bug and some other arthropods were identified as being resident predator-scavengers. In field conditions, the Wekiu bug has been observed feeding upon adult lady beetles, upon recently dead adult syrphid flies, and as mentioned above, even dead birds. The Wekiu bug has not been observed feeding upon other resident arthropods (Ashlock and Gagne 1983; Howarth 1997a; KAHEA 2003).

Both larval and adult Wekiu bugs, apparently remain active during winter months, and even exhibit activity at ambient air temperatures of minus 7 degrees Celsius (19 degrees Fahrenheit) (Frank Howarth, Bishop Museum, pers. comm., 1998; KAHEA 2003). They use snow to their advantage by feeding on insects that are either kept "fresh" or immobilized by the cold when they are escorted by winds to the summit. Although difficult to establish, it is widely believed the Wekiu bug has some obligatory association with snow and/or permafrost, the former for food, and the latter especially for year-around moisture. This would at least partly explain its restriction to higher elevations on Mauna Kea (KAHEA 2003). Wekiu bugs are fairly susceptible to dehydration, which is probably related to their attribute of abdominal physogastricity (extreme swelling) exhibited after feeding (Ashlock and Gagne 1983).

Wekiu bugs will emerge from beneath the tephra where they live, to feed and mate when the sun has warmed the rock surfaces, particularly at the margins of snow fields. Apparently, they will remain along the narrow melting, outer perimeter of a snowfield to take advantage of any frozen insects which drop from the receding snowfield perimeter (Howarth 1997a). Should a shadow cross the sun when Wekiu bugs are foraging in this warm, moist, food-rich habitat, they will quickly retreat deep into the tephra. Although not established with complete certainty, it is believed the distribution and biology of these bugs will be strongly linked with the tephra cinder cones present on Mauna Kea's summit (Ashlock and Gagne 1983; KAHEA 2003). During most surveys up to now, tephra habitats have yielded the highest capture rates for these bugs. It is believed it utilizes the tephra to their benefit by migrating vertically through the interstitial spaces according to day and night or seasonal temperatures. Most likely, the bugs also safely follow shifting snowfield edges by means of these spaces between the lightweight tephra (Howarth 1997b).

THREATS:

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>.

Due to certain ideal atmospheric qualities and ideal weather conditions at the summit of Mauna Kea, the University of Hawaii has developed the summit area as the Mauna Kea Science Reserve for astronomical study (Research Corporation of the University of Hawaii (RCUH) 1983). Since 1968, approximately 25 hectares (ha) (62 acres (ac)) of potential Wekiu bug and other Mauna Kea arthropod habitat has been lost to astronomy development on the summit. There are 4,532 ha (11,200 ac) in the Mauna Kea Science Reserve. The Reserve's lower elevational boundary ranges from 3,566 m (11,700 ft) to 3,688 m (12,100 ft). Above 3,658 m (12,000 ft), there are approximately 1,538 ha (3,800 ac) contained within the protected, State-owned natural area reserves (RCUH 1983). The absolute lower elevational range boundary of the Wekiu bugs is believed to be at approximately 3,658 m (12,000 ft) (Ashlock and Gagne 1983). More than two thirds of it
s potential range is unprotected from astronomical development.

To date, 14 telescopes (including the removal of one in 1994) and several buildings and associated structures have been constructed on the summit (KAHEA 2003). The 1985 Summit Management Plan authorizes a total of 13 telescopes (State Auditor 1998; KAHEA 2003). Resultant impacts have included road construction, parking areas, tourist facilities, temporary storage areas, substrate removal, and oil spills, and constant traffic to the summit with the concomitant human dispersal of trash and debris. The suspected preferred habitat of the Wekiu

bug, tephra cinders, are easily crushed to dust-sized particles, and vehicular traffic can quickly and permanently change a rocky tephra habitat to one of compacted silt and mud. Furthermore, the silt and mud has the potential to degrade nearby tephra habitat by filling the interstitial spaces between cinders that are used by this bug and other arthropods (Ashlock and Gagne 1983).

Since 1963, when the first modern road was bulldozed to the summit of Mauna Kea, an estimated 25 percent of the potential Wekiu bug habitat has been destroyed or degraded by astronomical development (F. Howarth, pers comm., 1998). The Institute for Astronomy receives and entertains new inquiries/proposals for telescope construction on an on-going basis (State Auditor 1998; KAHEA 2003). While few groups have the money to invest in Mauna Kea, due to the cost of operating the facilities and the shared maintenance, it remains one of the most desirable locations worldwide for astronomical observation. In addition to the possibility of new facility construction, many of the existing facilities and structures are nearly 25 years old and will probably soon require rebuilding and updating (State Auditor 1998; KAHEA 2003). This would likely include new construction and expansion.

B. Over-utilization for commercial, recreational, scientific, or educational purposes.

Not applicable.

C. Disease or predation.

Since the Wekiu bug and other Mauna Kea arthropods rely on the mechanics of an aeolian system for obtaining prey, the amounts and type of prey upon which they depend may be affected by introductions of alien arthropods and parasites (F. Howarth, pers. comm., 1998; KAHEA 2003). For example, the Wekiu bug now competes with at least one introduced species of Linyphiidae (small sheetweb) spiders which have become established on the summit (Howarth and Stone 1982; KAHEA 2003).

D. The inadequacy of existing regulatory mechanisms.

The summit area lies within a State conservation district and any construction in the area requires a permit from the State Department of Land and Natural Resources (DLNR) (State Auditor 1998; KAHEA 2003). Prior to development of the Mauna Kea Science Reserve, a development plan for the summit area was written that addressed the sensitivity of the Wekiu bug and its habitat. Despite the fact that important Wekiu bug habitat was identified as sensitive in the 1983 plan and was to be avoided in the development of the facilities, a lack of communication and monitoring of construction activities at the summit during construction of the Subaru telescope facility resulted in the loss of most Wekiu bug habitat in Puu Hau Oki (Fred Stone, University of Hawaii, *litt*.1996; State Auditor 1998) *in. litt*.1996; State Auditor 1998; KAHEA 2003).

A 1997 report on the State of Hawaii's audit of the management of Mauna Kea and the Mauna Kea Science Reserve states, "management of Mauna Kea fails to adequately ensure protection of our natural resources" (State Auditor 1998). In addition, unapproved construction activities on the summit area, unauthorized cinder cone and crater "reshaping" activities, and large spills of motor oil have been reported (F. Stone *in litt*. 1996; State Auditor 1998; KAHEA 2003).

In response to the State Auditor's 1998 report, the Institute for Astronomy, the University of Hawaii, and DLNR have agreed to better manage the Mauna Kea Science Reserve and its natural resources. Currently, the Institute for Astronomy is developing a new Mauna Kea Science Reserve master plan and is funding a series of surveys to determine how the impact of future development might impact the flora and fauna (particularly the Wekiu bug) of the summit area (State Auditor 1998). Under the current management plan, the number of telescopes is limited to 13. However, old facilities can be torn down and replaced with sub-millimeter arrays which can have up to 20 times the surface impact of construction of a standard telescope and still count as one telescope (State Auditor 1998).

Furthermore, development of interferometers on Mauna Kea may continue under the current management plan since they do not count as "telescopes". Interferometers are specialized antennae for observing astronomical occurrences, and the resulting structure impacts at least as much surface area as a large telescope (State Auditor 1998; KAHEA 2003).

E. Other natural or manmade factors affecting its continued existence.

Shifts in global climate (toward warmer winters with less snowfall on the Mauna Kea summit) may potentially threaten the Mauna Kea arthropods, including the Wekiu bug (KAHEA 2003). The summit area has been warmer and has had less snowfall since 1982 (Howarth 1997a). The capture rates for Wekiu bugs in a 1997 study were significantly lower than the rates obtained in the 1982 study (Howarth 1997c; KAHEA 2003). It is possible that as the summit area becomes warmer over time, alien predators and parasites could more easily establish themselves or have indirect effects on the Wekiu bug's food supply. In addition, if available habitat is seriously reduced by summit development, the Wekiu bug will likely be less capable of responding and surviving during climatic changes (F. Howarth, pers. comm., 1998; KAHEA 2003).

FOR RECYCLED PETITIONS:

a. Is listing still warranted? Yes

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? Yes

c. Is a proposal to list the species as threatened or endangered in preparation? No

d. If the answer to c. above is no, provide an explanation of why the action is still precluded. On May 21, 2003, we received a petition dated May 22, 2003, from KAHEA to list the Wekiu bug. We thoroughly reviewed information provided in the petition and in our files, and contacted State officials with the Department of Land and Natural Resources, Bishop Museum and University of Hawaii researchers, and the Office of Mauna Kea Management, before determining that emergency listing of the Wekiu bug is not warranted at this time. Since publication of the 2002 CNOR, the publication of a proposed rule to list this species has been precluded by other higher priority listing actions, and based on work scheduled, we expect that will remain the case for the remainder of fiscal Year 2004. Almost the entire national listing budget has been consumed by work on various listing actions taken to comply with court orders and court-approved settlement agreements, emergency listing, and essential litigation-related, administrative, and program management functions. We will continue to monitor the status of the Weiku bug as new information becomes available. This review will

determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

LAND OWNERSHIP:

This species occurs only on the upper Mauna Kea summit, which is owned by the State of Hawaii and managed by the Institute for Astronomy.

PRELISTING:

Several members of the local community and the scientific community are interested in and have taken active steps to help protect the arthropod fauna of the Mauna Kea summit. In 1982, two biological surveys above the 3,963 m (13,000 ft) level were completed as part of the environmental impact studies for planned construction of astronomy facilities. A second, more inclusive environmental impact study was conducted in 1985, which developed into the first Mauna Kea Master Plan (a summit management plan).

In 1997 and1998, the Bishop Museum was contracted by the Institute for Astronomy to conduct research necessary for development of an arthropod conservation plan for the Mauna Kea summit. The Bishop Museum's goal was to develop and include adequate protection for the Wekiu bug in the Mauna Kea Science Reserve Master Plan.

The adoption of the Mauna Kea Science Reserve Master Plan by the University of Hawaii Board of Regents in June 2000 effectively changed the management of all activities on Mauna Kea. The Master Plan established management guidelines for the next 20 years. The process reflected the community's concerns over the use of Mauna Kea, including respect for Hawaiian cultural beliefs, protection of environmentally sensitive habitat, recreational use of the mountain, as well as astronomy research. The Master Plan places the focus of responsibility at the University of Hawaii at Hilo. UHH Chancellor Rose Tseng established the Office of Mauna Kea Management (OMKM) and Mauna Kea Management Board (MKMB) in the fall of 2000.

In June 2001, the State contracted a Smithsonian Institution researcher to do one survey of Puu Hau Kea within a Natural Area Reserve within the summit area.

During April, May, and September of 2002, additional surveys for the Wekiu bug were conducted by the Bishop Museum as contracted by the State for the purpose of further delineating the species' habitat range.

Beginning in February 2002, to study the effects of habitat mitigation, the Keck Observatory contracted an independent researcher (Pacific Analytics, L. L. C.) to conduct quarterly surveys and baseline monitoring for the Wekiu bug in and around the Puu Hau Oki crater and those areas adjacent to the observatory.

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LISTING PRIORITY (* after number)

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2*
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: The magnitude of threats to the wekiu bug and its habitat is high because the species has a very limited range and very specific habitat requirements. These habitat requirements coincide with areas that have been identified as high priority areas for telescope development.

Imminence: The immediacy of the threats are high because there is ongoing development occurring in the wekiu bug's habitat range, most recently with the Keck Observatory Outrigger telescope development. In addition, the Institute for Astronomy has identified long term development plans for additional telescopes within the wekiu bug's habitat range.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes to the candidate list, including listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all additions of species to the candidate list, removal of candidates, and listing priority changes.

Approve: Carolyn Bohan April 15, 2004
Acting Regional Director, Fish and Wildlife Service Date

Concur: Steve Williams April 19, 2004
Director, Fish and Wildlife Service Date

Do not concur:_____ _____
Director, Fish and Wildlife Service Date

Director's Remarks:
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_____
_____
_____

Date of annual review: 4/04
Conducted by:_____

Comments:
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