Written Direct Testimony of Jesse Eiben, Ph.D

Testimony for TMT Contested Case regarding the wēkiu bug, Fall 2016
Dr. Jesse Eiben, PhD, Assistant Professor of Entomology, University of Hawai'i at Hilo, College of Agriculture, Forestry and Natural Resource Management ("**CAFNRM**")

I attest that the testimony I submit as part of this Contested Case Hearing is not a specific required duty as part of my employment at University of Hawai'i at Hilo ("**UHH**"). Dean Mathews (of CAFNRM) and Chancellor Straney have been informed of this, and agree that my participation in this hearing is voluntary and of my own volition. The testimony I am providing is part of the service that UHH faculty provide to the community when the circumstances require our expertise. It is our duty as faculty to offer information when our specialized training and experience is needed. It is within that framework that I have agreed to participate in this Contested Case Hearing.

I have a master of science degree in entomology from Oklahoma State University. I obtained my Ph.D. in entomology from the University of Hawai'i at Manoa in 2012. My Ph.D. dissertation thesis was on applied conservation research of the wēkiu bug in Hawai'i. I am currently an assistant professor of applied entomology at UHH. I have spent years studying the wēkiu bug and its habitat on Maunakea, and I am not aware of anyone who has greater familiarity with this subject than I do. My curriculum vitae was submitted as Exhibit A-41.

Overview of TMT Site Wēkiu bug impacts

As discussed in detail in the Final Environmental Impact Statement ("**FEIS**") for the Thirty Meter Telescope ("**TMT**") project, the potential adverse impacts the project may have on the wēkiu bug and its habitat will be mitigated by the TMT project's planned implementation of the mitigation measures. *See* Exhibits A-3, A-4 and A-5, Appendix K at 31-33. Thus, the TMT project's impact on the wēkiu bug and its habitat will be less than significant. *See* Exhibit A-3, §3.4; Exhibit A-5, Appendix K at 20.

As stated in the TMT FEIS, wēkiu bugs (*Nysius wekiuicola*) are found primarily in habitat composed of loose cinder found on cinder cones above 11,715 feet on Maunakea. The wēkiu bug is a unique component of the high elevation aeolian alpine ecosystem on Maunakea. The wēkiu bug differs from most other *Nysius* species in its predatory habits, unusual physical characteristics and high elevation habitat. It is not known to exist anywhere other than within this alpine ecosystem on Maunakea above ~11,000 feet.

General Description of Wēkiu Bug Habitat

In trapping surveys, wēkiu bugs are captured predominantly in areas with an assemblage of different sized rock cinder scoria with a depth of approximately 2 to 10 inches above the ash layer. This mixed rock tephra is found on the slopes of cinder cones. The areas where wēkiu bugs are found show a constant state of flux, with the scoria slowly moving down slope by the force of gravity and undergoing frost-heaves that continually "sift" dust and ash downward, thereby creating a natural and very slow sorting with larger rocks nearer the surface and smaller cinders closer to the ash layer. This habitat type is highly suitable for supporting populations of wēkiu bugs. Additional surveys conducted by Office of Maunakea Management ("**OMKM**"), Bishop Museum, and my lab members at University of Hawai'i at Hilo and at Mānoa since 2011 have continued to show this association of wēkiu bugs on cinder cones.

There are many interconnected reasons why wēkiu bugs are associated with this specific type of habitat. Wēkiu bugs can thermoregulate by moving through the crevices created by the sorting of the rocks. These crevices also provide paths for escape from predators. Temperature and humidity vary within the few inches of rock, with humidity and temperature being inversely correlated. Near the ash layer, the temperature is lower and humidity is higher. Conversely, at the surface where wēkiu bugs bask in the sun, the temperature can be very high with extremely

low humidity. These microhabitats are necessary physiologically for the wēkiu bug. They also provide areas that store and preserve prey items, primarily insects, on which wēkiu bugs feed. Insect prey fall out of the wind column as the wind blows across the summit region land and are sifted downward within the scoria. This downward sifting protects the fallen prey from the intense desiccating conditions found at the surface, allowing that prey to remain more suitable for wēkiu bug feeding for longer periods of time than would be possible when fully exposed to sunlight and low relative humidity air. Exhibit A-5, Appendix K, Sub-appendix B at B-5.

Maunakea Alpine Ecosystem Habitat Descriptions

Six habitat types have been described within this alpine ecosystem, and not all are equally suitable for arthropods including the wēkiu bug. They are:

Type 1 Snow patches. Seasonal patches of snow that provide moisture and help retain food for the summit arthropods, but are not directly utilized by any of the species.

Type 2 Tephra ridges and slopes. Tephra cinder (> 1 cm) are fragmental material produced by a volcanic eruption found on cinder cones. The interstitial spaces provide a micro, humid habitat for the smaller arthropods including wēkiu bugs, spiders, and caterpillars. Wēkiu bugs are found in greatest abundance in this habitat.

Type 3 Loose, steep tephra slopes. Contains smaller cinders that are subject to downward creep. Wēkiu bugs are found in low abundance in this habitat.

Type 4 Lava flows. Aca and pahoehoe flows with large outcrops of andesitic (iron-poor gray lava) rock are the primary habitat for the moth, the spider, and the centipede, but the wēkiu bug is rare in this habitat due to the lack of suitable microclimate.

Type 5 Talus slopes and fractured rock outcrops. Composed of rock rubble and highly fractured rock outcrops and depressions between lava flows with glacially deposited, rounded rocks. Small voids provide suitable microhabitat for the wēkiu bug, which can occur in moderate abundance during times of high population outbreaks.

Type 6 Compacted ash, silt, and mud. Found along roadsides and disturbed areas. The interstitial spaces are filled with fine-grained material and are not suitable for wēkiu bugs and spiders. Exhibit A-3 at 3-63.

Currently, my lab and collaborators are working on refining the associations wēkiu bugs have with habitat descriptions and with wēkiu bug presence and relative density. This new analysis (2014-2016) indicates elevation (higher is better), and hematite classified rock substrates (more so than other rock classifications) are highly associated with wēkiu bug presence and higher densities. These are the conditions found on the majority of cinder cones, not glacial till or striated areas. The TMT site is planned for non-wēkiu bug habitat, as the TMT building site does not consist of hematite. The beginning of the road corridor does contain hematite, and the road opening would impact a very small amount of the overall hematite wēkiu bug habitat. Type 2 and Type 3 habitat are consistent with hematite rock areas at high elevation (above 11,000 feet, and with generally steep slopes (>20 degree slope)). This rock-substrate association is being analyzed in two different research projects at UHH, and the detailed maps and analysis of wēkiu bug habitat has been accepted for review in the Journal of Insect Conservation (2016). I hope this publication will be available for reference after peer review by November 2016.

Habitat Type in TMT-Related Area

Area E, where the TMT project is proposed to be built, is largely comprised of Type 4 habitat with smaller areas comprised of Type 5 habitat. The bulk of the TMT access road is similar to the substrate of Area E, while the section that skirts the base of Pu'u Hau Oki is considered Type 3 habitat.

The lava substrate in Area E is not considered to be ideal wēkiu bug habitat. To my knowledge, wēkiu bugs have only been found in Area E very occasionally during two sample events that occurred during particularly abundant years for the bugs (Howarth and Stone 1982, recent OMKM survey). The loose cinder adjacent to the existing access road is highly suitable as wēkiu bug habitat, consisting of different sized cinders larger than 1/2 inch in a depth of 2-10 inches above the ash layer. Exhibit A-5, Appendix K at 14.

Wēkiu bug Surveys of TMT-Related Areas

I conducted surveys of the areas proposed for use by the TMT, including Area E, the summit batch plant staging area, and the access road in the Fall of 2008 and Spring of 2009. Despite intensive sampling, we did not detect any wēkiu bugs during the Fall 2008 survey in any of these areas, but wēkiu bugs were detected in areas outside the proposed TMT use areas, albeit in very low numbers. Exhibit A-5, Appendix K, Sub-appendix A at A-4. During the Spring survey, a total of 146 wēkiu bugs were observed in the baited live-traps and in the immediate vicinity of the traps by visual observation along the access road and in nearby cinder cone habitats with no planned direct impact by construction activities. No wēkiu bugs were found in Area E or in the summit batch plant staging area. Exhibit A-5, Appendix K, Sub-appendix B at B-4. The Fall and Spring survey results are consistent with previous and

subsequent surveys showing that throughout the wēkiu bug's range, the number of bugs trapped during the Fall is much lower than the number found during other times of the year. In particular, wēkiu bugs are found in higher numbers during late Spring and early Summer, and this may be correlated with lasting snow pack. Exhibit A-5, Appendix K, Sub-appendix A at A-4. Continued surveys for native and introduced arthropods along the access road and proposed TMT site area have continued with OMKM and Big Island Invasive Species Committee ("**BIISC**") projects through 2016, of which I have taken part. Wēkiu bug populations are not found in TMT site areas, except along the start of the proposed access road area, as was found in 2009.

The survey data show that relative wēkiu bug densities are higher in some of the cinder cone habitats that are nearby the access road, but not immediately adjacent to it. Daily trapping rates are approximately 20 times higher on these cinder cones than on or in the immediate vicinity of the access road. For example, traps placed about 10 - 20 meters away from the Submillimeter Array road on the bottom slope of the eastern side of Pu'u Poli'ahu captured 12 times more wēkiu bugs than do traps placed adjacent to the access road (2009 data).

Impact of Construction

It is highly unlikely that the substrate modification by construction activities within Area E would have a significant impact on wēkiu bug population elsewhere within the Mauna Kea Science Reserve. The batch plant staging area, where the substrate has already been altered, is disturbed regularly, and past activity there has not appeared to impact wēkiu bug populations elsewhere. Construction activities there would not likely have any significant impact. Exhibit A-5, Appendix K at 20.

Construction of the access road will likely kill wēkiu bugs residing in the direct path of any rock movement, and active road use areas will remove a very small amount of habitat from the available habitat pool. Since there are fewer bugs in the access road cinder habitat than in nearby cinder cones, and the area to be disturbed is quite small when compared to the nearby higher relative density wēkiu bug capture areas, the loss of wēkiu bugs immediately in the path of road construction will not have a permanent negative effect on the overall population of wēkiu bugs. It should be noted that the cinder adjacent to the access road was disturbed in the past and still contains wēkiu bugs. The population of the species will not be significantly impacted by the disturbances of the small area of habitat along the access road, including those habitat areas on Pu'u Hau'oki. The limited number of wēkiu bugs that are likely to be killed by the construction activities is so small that they could be replaced by one (1) hour of normal wēkiu bug propagation by the population existing above 13,000 feet (calculated from growth model). Exhibit A-42 (Eiben & Rubinoff 2014). Additionally, any potential adverse impacts on the wēkiu bug and its habitat, such as dust generated from excavation and site preparation, wind-blown debris, and potential introduction of invasive species, will be mitigated by TMT's planned implementation of the recommendations contained in Appendix K of the TMT FEIS. Exhibit A-5, Appendix K at 31-33.

There has been continual monitoring of wēkiu bugs and additional information regarding the distribution and relative abundance of wēkiu bugs on Maunakea since 2011. The Office of Mauna Kea Management has conducted arthropod species monitoring with my involvement, oversight, training, and review. I have also conducted additional field research that has observed wēkiu bugs throughout their range above 11,000 feet in Maunakea since 2011. There is no consistent record of decline of wēkiu bugs on Maunakea, nor has there been a retraction in

overall range of the insect. In 2011, the wēkiu bug was also removed as a Candidate Endangered Species from the United States Fish & Wildlife Service's endangered species list.

I have published two additional research papers (along with other co-authors) regarding the conservation of endemic Hawaiian arthropods and the wēkiu bug since 2011 (see citations below).

I have been conducting overall arthropod diversity (location, range and relative densities) research on Maunakea since 2012, and have obtained additional information regarding all arthropod taxa encountered on Maunakea above ~9,000 feet in UHH managed lands. This research has included grants from OMKM and TMT to collect and identify native and non-native arthropods within the UHH managed lands. This research has not identified any additional threats to the wēkiu bug that have not been previously known, and this research has helped classify the habitat types and species-specific requirements for native and non-native arthropods. Species specific habitat range and composition models, including the habitat of the wēkiu bug, are currently in review with a peer reviewed academic journal. These habitat range models show the extent of endemic high alpine arthropods on Maunakea, and the extent of these ranges are much broader than just the footprint of the proposed TMT. (See previous discussion of new article regarding habitat mapping in peer review.)

If the construction activities of the TMT are still to be located in the same places as presented in 2011, with the newly obtained information regarding native and non-native arthropod species over the past 5 years (2011-16), I still have no evidence that will lead me to predict that the direct construction footprint will lead to the likelihood of permanent negative effects on the wēkiu bug.

Again, direct construction impacts (habitat destruction) will remove acreage available for native arthropod species that reside only above ~11,000 feet on Maunakea, however, the amount of acreage removed will not immediately imperil the wēkiu bug or other endemic taxa I have studied, since the total acreage available as habitat is still extensive (the TMT Project activities will affect less than 1% of the total wēkiu bug habitat; including only 0.2 acres of cinder cone habitat).

I stand by my statements that mountain-wide effects of human impacts, such as climate change or invasive species movement, will possibly negatively impact wēkiu bugs. However, TMT construction alone will not substantially impact the wēkiu bug population, and mitigation efforts can limit negative effects on the wēkiu bug to be less than significant.

Recent Publications:

- **Eiben, J.** and Rubinoff, D. (2014) Application of agriculture developed demographic analysis for the conservation of the Hawaiian alpine wēkiu bug. Conservation Biology, 28(4). 1077-1088. (Exhibit A-42).
- Medeiros, M.J., **Eiben, J.A.**, Haines, W.P., Kaholoaa, R.L., King, C.B.A., Krushelnycky, P.D., Magnacca, K.N., Rubinoff, D., Starr, F., & Starr, K. (2013). The importance of insect monitoring to conservation actions in Hawai'i. Proceedings of the Hawaiian Entomological Society 45. 149-165.
- **Eiben, J.** and Rubinoff, D. (2010) Life history and captive rearing of the Wēkiu bug (*Nysius wekiuicola*, Lygaeidae), an alpine carnivore endemic to the Mauna Kea volcano of Hawai'i. Journal of Insect Conservation, 14(6). 701-709.

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Jesse Eiben

Jesse Eiben, PhD

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