Appendix C

Section 7 Consultation

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DEPARTMENT OF THE ARMY
HEADQUARTERS,
UNITED STATES ARMY GARRISON
PŌHAKULOA
PO BOX 4607
HILO, HAWAII 96720-0607

IMPC-HI-PS

MEMORANDUM FOR RECORD 15 April 2011

SUBJECT: ESA-7(c) Determination of No Effect for High-Altitude Mountainous Environmental Training (HAMET) at Mauna Loa and Mauna Kea, Hawaii Island

The US Army developed the HAMET program to prepare pilots for successful combat operations as part of Operation Enduring Freedom in Afghanistan (US Army, 2009). HAMET involves three phases: 1) academic and simulator training; 2) basic qualification, and; 3) tactical operations exercises. HAMET is essential pilot training because high altitudes and mountainous terrain produce aerodynamic and atmospheric effects on rotary-wing aircraft that differ from effects at lower altitudes and over moderate terrain. Conditions at high altitudes may include high winds, extreme turbulence, low air density, and unpredictable air mass stability. These conditions can significantly affect engine performance and handling characteristics of rotary-wing aircraft (US Army, 2011). Army helicopter pilots need to understand and experience the challenges of flight planning and aircraft operations at high altitudes in order to be competent for missions in mountainous environments such as Afghanistan.

In preparation for deployment to theatre of operation and to satisfy compulsory aviation training requirements, the 25th Combat Aviation Brigade stationed at Wheeler Army Airfield, Hawaii, proposes to provide HAMET for helicopter aviators at landing zones (LZs) on Mauna Loa and Mauna Kea, Hawaii. The proposed action sustains Department of Army and Department of Defense training requirements and meets HAMET Phase 3 objectives. Aviators and crews will train on aircraft internal to the 25th Combat Aviation Brigade, Hawaii.

The US Army has developed Action Alternatives and a No Action Alternative to evaluate the proposed HAMET Action, as described in the HAMET Environmental Assessment (US Army, 2011). The No Action Alternative serves as a benchmark against which the proposed alternatives can be evaluated. Since the proposed action is to conduct HAMET Phase 3 tactical operations exercises, the purpose of the Action will not be achieved if the No Action Alternative is selected (US Army, 2011).

Action Alternatives involve the execution of HAMET flights between Bradshaw Army Airfield at Pohakuloa Training Area and six landing zones (LZs) selected on Mauna Kea and Mauna Loa. These six LZs were chosen based on training-appropriate characteristics and safety considerations. The selected LZs meet the criteria for HAMET objectives and are suitable for use without further modification.

Biological resources within the HAMET project area include vegetation and wildlife. Potential impacts to vegetation resources (including palila critical habitat) include habitat loss from wildland fire, temporary impacts from dust and wind generated from helicopter rotorwash, and the spread of invasive species. Potential impacts to wildlife resources are limited to noise disturbance and direct impact with aircraft.

Botanical surveys were conducted 23 February 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3, and 24 February 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6, to determine the presence of federally-listed plant species and to assess overall vegetation in the general vicinities of the LZs. See Peshut and Evans Memorandum For Record 30 March 2011 (see References). Survey areas for each LZ included a square ~650 ft (200 m) on each side centered on the geographic coordinate of respective LZs. No federally-listed or candidate species were located at any of the LZs or within any LZ survey area. In general, vegetation at the LZs is extremely sparse or absent, and is limited to a few common native or introduced species.

Surveys to assess potential available treeland roosting habitat and potential foraging habitat for the federally-listed Hawaiian Hoary Bat were conducted 02 March 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3, and 03 March 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6, to determine the potential for bat presence in the general vicinities of the LZs. See Peshut and Doratt Memorandum For Record 04 April 2011 (see References). Survey areas for each LZ included a square ~650 ft (200 m) on each side centered on the geographic coordinate of respective LZs, similar to the survey area for the botanical surveys. Botanical survey data was used to augment the assessment of potential bat habitat. As described for the botanical surveys, in general, vegetation at the LZs is extremely sparse or absent, and is limited to common native or introduced species. The Mauna Kea LZs are essentially devoid of vegetation and provide no habitat that could reasonably be considered as potential roosting or foraging habitat for the Hawaiian Hoary Bat. Vegetation at the Mauna Loa LZs is also extremely sparse, and there is no vegetation greater than 3 ft in height within any of the Mauna Loa LZ survey areas. Overall, the LZs do not provide significant potential roosting or foraging habitat for the Hawaiian Hoary Bat. Bat presence within the LZ areas is expected to be limited to rare and infrequent transiting bats, and bat density in the LZ areas is expected to be extremely low.

Surveys to assess the potential presence of the candidate species *Nysius wekiuicola* (Wekiu bug) and the presence of invasive arthropod species were conducted 02 March 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6. The Wekiu bug does not inhabit Mauna Loa LZs. See Peshut and Doratt Memorandum For Record 04 April 2011 (see References). Survey areas for each LZ included a circle of ~650 ft (200 m) radius centered on the geographic coordinate of respective Mauna Kea LZs. Although surveys were considered preliminary due to seasonality of Wekiu bug behavior, the summit of cinder cones for LZ 5 and LZ 6 do not provide preferred Wekiu bug habitat. The conditions at LZ 4 do not provide Wekiu bug habitat. No invasive arthropods were found during the surveys. Surveys will be repeated during the April-June time frame to provide a conclusive determination of Wekiu bug absence or presence at the Mauna Kea LZs.

Surveys to determine bird presence and habitat use in the general vicinities of the LZs were conducted 02 March 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3, and 03 March 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6. See Peshut and Schnell Memorandum For Record 04 April 2011 (see References). Survey areas for each LZ included a circle of 2000 ft (610 m) radius centered on the geographic coordinate of respective LZs, corresponding to the 80 dB noise contour for helicopter operations at LZs. Although surveys for seabirds were considered preliminary due to seasonality of seabird behavior, potential seabird colony habitat within the LZ areas is minimal and the presence of colonies is considered highly unlikely. Surveys will be repeated during the May-August time frame to provide a conclusive determination of seabird colony absence or presence at the LZs. Several bird species protected under the Migratory Bird Treaty Act were identified at the LZs, as were game bird species not protected under federal law. Overall densities of these birds within the survey areas were extremely low. These bird species are expected to temporarily vacate the immediate area during HAMET operations. The Hawaiian Goose (Nene) is known to frequent the regions within several miles of the Mauna Loa LZs, but geese densities are expected to be extremely low in the areas of LZs, and if present geese are expected to temporarily vacate the immediate area during HAMET operations. Nene are not expected to be present in the vicinities of the Mauna Kea LZs.

Use of the selected LZs for HAMET operations will not significantly affect threatened and endangered species or designated critical habitat as protected under the Endangered Species Act. Use of the selected LZs will not significantly affect bird species that are protected under the Migratory Bird Treaty Act. Upland game birds, not protected under federal law, but which are considered to be an important part of the biological resources in the vicinities of the LZs, will not be significantly affected by HAMET operations.

The impact to vegetation resources from wildland fire generated from a helicopter crash at an LZ is negligible because of the extremely sparse vegetation around the LZs, which provides a low density fuel load and limits the spread of fire. The effects to vegetation communities surrounding the LZs due to wind and dust generated from helicopter

landings and maneuvers is insignificant because vegetation in the vicinity of the LZs is extremely sparse and low lying, or absent, and there is little or no entrained fine-grained material in the lava substrate of the LZs.

There are no effects to vegetation from human foot traffic because there is no disembarkation of personnel during HAMET operations.

The impact to vegetation and wildlife resources from wildland fire generated from a helicopter crash along a flight path to an LZ (including over palila critical habitat) during flight operations, is considered negligible. For the military, hundreds of helicopter flights and thousands of hours of flight time are logged at Pohakuloa each year. Moreover, commercial helicopters plying the tourist trade on Hawaii Island transit palila critical habitat regularly throughout the year, with no restrictions on flight paths or elevation. At a larger scale, thousands of commercial flights for public and private travel cross population centers and biologically sensitive areas daily, across the globe. Aircraft crashes are phenomenally rare given the numbers of aircraft and flight hours logged worldwide. The potential for a helicopter crash from HAMET operations is insignificant by comparison. The significant probability of a helicopter crash during HAMET operations was not considered tenable.

The spread of invasive species within the project area will be reduced by inspecting and cleaning the exterior of the HAMET aircraft at the Bradshaw Army Air Field prior to training flights.

The potential impact to federally-listed wildlife from collisions with aircraft is insignificant. The potential for a collision with the Hawaiian Hoary Bat is unlikely because the bats are solitary, are only active from sunset to sunrise, only roost in trees in forested areas, and are not expected to depend upon the habitat around the LZs for resources. Collision with palila is highly unlikely because the selected flight paths are over the unoccupied portions of the habitat and aircraft will maintain an altitude of at least 2000 feet above ground level when flying over critical habitat. An air collision with the Nene is equally unlikely. The island-wide population of nene is ~500, of which only ~200 are known to transit Pohakuloa between population centers in Hakalau (east) and Puuanahulu (west). Nene do not spend a significant portion of their time in the air, and do not typically fly at night. Nene spend most of their time on the ground, loafing, feeding, sleeping, or tending nests. For these reasons, the likelihood of an air collision with Nene is considered to be remote.

The impact to biological resources due to noise is considered negligible. HAMET operations will produce ~10 minutes of noise disturbance per LZ landing event, with the highest noise levels ~100 dB within ~100 ft of the geographic center of the LZ.

In summary, the US Army will implement the following mitigation measures for HAMET operations to minimize or eliminate the likelihood of adverse effects to plant and animal species within the project area:

- Helicopters will maintain an altitude of at least 2000 feet above ground level when flying over palila critical habitat;
- Helicopters will utilize selected flight paths to avoid flying over the occupied palila critical habitat;
- Helicopters will be inspected for invasive arthropod and plant species prior to each mission, and cleaning protocols will be followed if invasive species are identified;
- Firefighting resources will be on stand-by while HAMET operations are conducted and transportation will be available for firefighting personnel;
- All pilots will be briefed on the mitigation requirements prior to HAMET missions.

Based on field surveys and supporting documents, the US Army has determined that the HAMET operations will have no effect on federally-listed species or federally-designated critical habitat within the project area.

This assessment and supporting documents satisfy US Army responsibilities under Section 7(c) of the Endangered Species Act at this time. The US Army will continue to remain aware of any change in the status of these species or critical habitat, and will be prepared to re-evaluate potential project impacts if necessary.

Point of contact to discuss this no effect determination is Peter Peshut, 808-969-1966, peter.peshut@us.army.mil.

PETER J. PESHUT, PhD
Program Manager
Natural Resources Office
Pohakuloa Training Area

References

Peshut, P.J. and Evans, S.A. 2011. Memorandum for Record. Botanical Surveys for HAMET Environmental Assessment. US Army Garrison Hawaii, Pohakuloa Training Area Natural Resources Office, 11 pp.

Peshut, P.J. and Doratt, R.E. 2011. Memorandum for Record. Wekiu Bug and Invasive Ants Surveys for HAMET Environmental Assessment. US Army Garrison Hawaii, Pohakuloa Training Area Natural Resources Office, 20 pp.

Peshut, P.J. and Doratt, R.E. 2011. Memorandum for Record. Hawaiian Hoary Bat Surveys for HAMET Environmental Assessment. US Army Garrison Hawaii, Pohakuloa Training Area Natural Resources Office, 5 pp.

Peshut, P.J. and Schnell, L.D. 2011. Memorandum for Record. Hawaiian Avifauna Surveys for HAMET Environmental Assessment. US Army Garrison Hawaii, Pohakuloa Training Area Natural Resources Office, 47 pp.

US Army. 2009. Army Aviation High-Altitude Mountainous Environmental Training Strategy. http://www.army.mil/standto/archive/2010/03/09/print.html. Web page updated 09 March 2010.

US Army. 2011. Environmental Assessment for High-Altitude Mountainous Environmental Training (HAMET) for the 25th Combat Aviation Brigade.

Appendix D

Section 106 Consultation

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DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
851 WRIGHT AVENUE, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HAWAII 96857-5000

REPLY TO
ATTENTION OF:

APR 15 2011

Office of the Commander

Mr. William Aila
State Historic Preservation Officer
Chairperson
Department of Land and Natural Resources Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, HI 96707

Dear Mr. Aila:

I am in receipt of the memo from Ms. Theresa Donham, SHPD Hawaii Island Archaeologist, regarding the Environmental Assessment (EA) and Section 106 consultation for the proposed High Altitude Mountainous Environment Training (HAMET). I am writing to clarify some points raised by the letter. The Environmental Assessment is currently under revision, and some of the points raised by Ms Donham will be addressed in the revised document.

With regard to the discrepancies between the EA project area and Area of Potential Effect (APE), we have revised the APE to include an area encompassing 100 meters diameter from the center of the landing zones (Enclosure 1) to take into account the potential effects of rotor wash. The helicopters will follow specific flight routes for the proposed trainings (Enclosure 2). They will fly 2000 feet above ground level to a release point, and from that point they will begin descent to the landing zones. Based upon discussions with the pilots, rotor wash begins to affect the ground once the helicopters have reached an altitude of 90 feet above ground level. This altitude will be reached at 100 meters from the center of the landing zone. In addition, most of the effects of rotor wash on the ground are felt on liftoff. Thus, the overall acreage for the six discontinuous APEs is 14.8 acres. The map in the original draft EA depicted available airspace according to the Federal Aviation Administration, and was not intended to depict the project area. Training will be restricted to these landing zone locations using modern GPS equipment, which has improved in recent years in accuracy and reliability. In addition, the pilots are briefed before they begin the high altitude training on the sensitivity of the area for cultural resources and the importance of landing only in the landing zones.

PTA Cultural Resources staff has surveyed the APE as defined above (see Enclosures 3 and 4). The flight routes are generally available to all aircraft that fly through the Saddle Region and are not specific to effects from this project. No historic properties were identified within the 100 meter square area at the LZs on Mauna Loa. On Mauna Kea, the mound previously identified by PTA Cultural Resources staff (Godby & Head 2003) was found to be 50 meters from the center of the LZ. For the purposes of the EA and this consultation this LZ is identified as LZ 6; it was formerly identified as LZ 5a. The mound is still present on this unnamed pu'u, and is in good condition. In addition, two more mounds were identified near LZ 5. One mound is 80 meters from the center of LZ 5, the other is 146 meters from the center of the LZ. Detailed descriptions of these mounds can be found in Enclosure 4. The mounds consist of piled 'a'ā cobbles. No other materials – pre-Contact artifacts, historic artifacts, or modern rubbish – were found in association with these mounds.

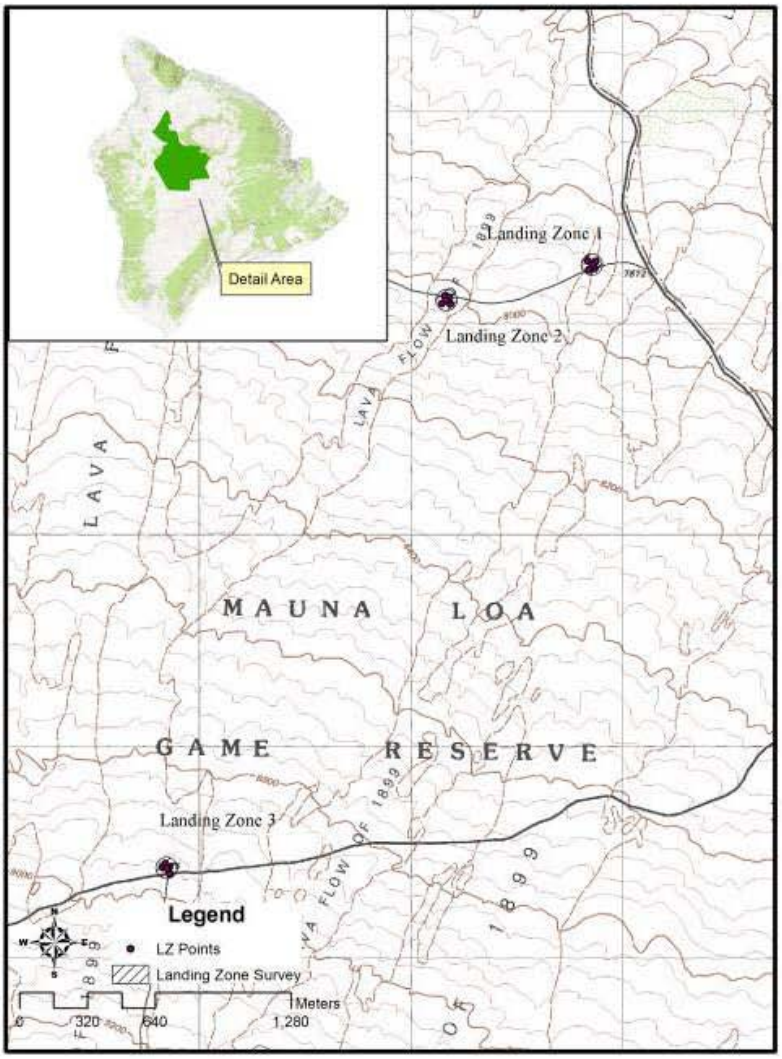
During a two week period for which DLNR issued a permit for Army helicopters to fly to the Mauna Kea landing zones for the purposes of collection additional data for the EA, PTA Cultural Resources staff revisited the Mauna Kea LZs twice to assess any effects of rotor wash or other unanticipated effects of the helicopter training scenarios on the mounds. Details of the first visit, after the first two days of helicopter flights, are found in Enclosure 5; details of the final site visit, after completion of the two week period, are found in Enclosure 6. There were no observable effects to the mounds from the helicopter activities. Noise monitoring was also done during this time, with monitors placed at the locations indicated on the map at Enclosure 7. PTA Cultural Resources staff accompanied the personnel who placed the noise monitors and an Office of Mauna Kea Management Ranger to ensure that no archaeological sites on Mauna Kea were disturbed either in the placement of the monitors or in the hike to the monitoring locations.

In sum, the concerns expressed by the SHPD have been addressed in this letter with regard to the Section 106 consultation. Concerns specific to NEPA are being addressed in the revised EA. The US Army Garrison Hawaii anticipates presenting the EA and the request to conduct training at these LZs to the Board of Land and Natural Resources hearing in late May or early June. We would appreciate notification from the SHPD of any additional concerns by May 6, 2011 so that they can be addressed. In the absence of an indication that there remain concerns regarding this Section 106 consultation we will assume that there are none and that you concur with my determination that this project will have no adverse effect to historic properties. Should you require additional information about this project, please contact Dr. Julie M. E. Taomia, PTA Archeologist, at telephone number (808) 969-1966.

Sincerely,

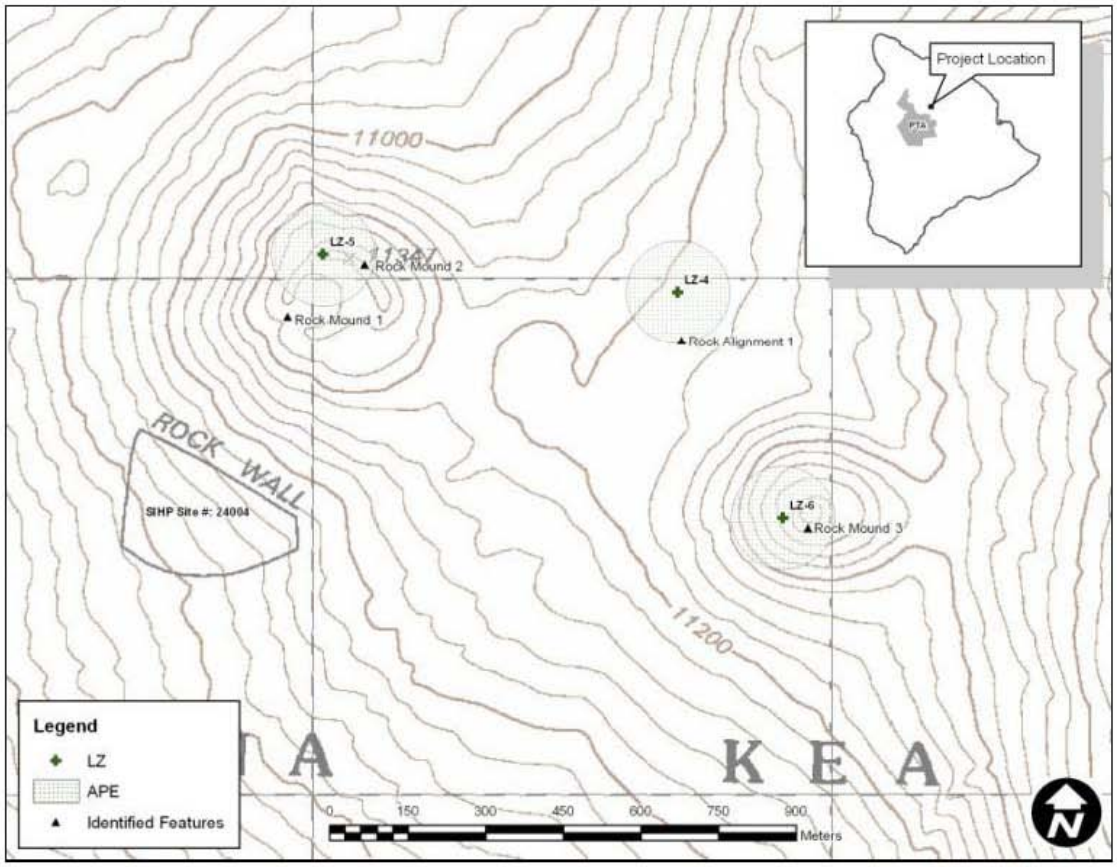
Douglas S. Mulbury
Colonel, US Army
Commanding

Enclosures

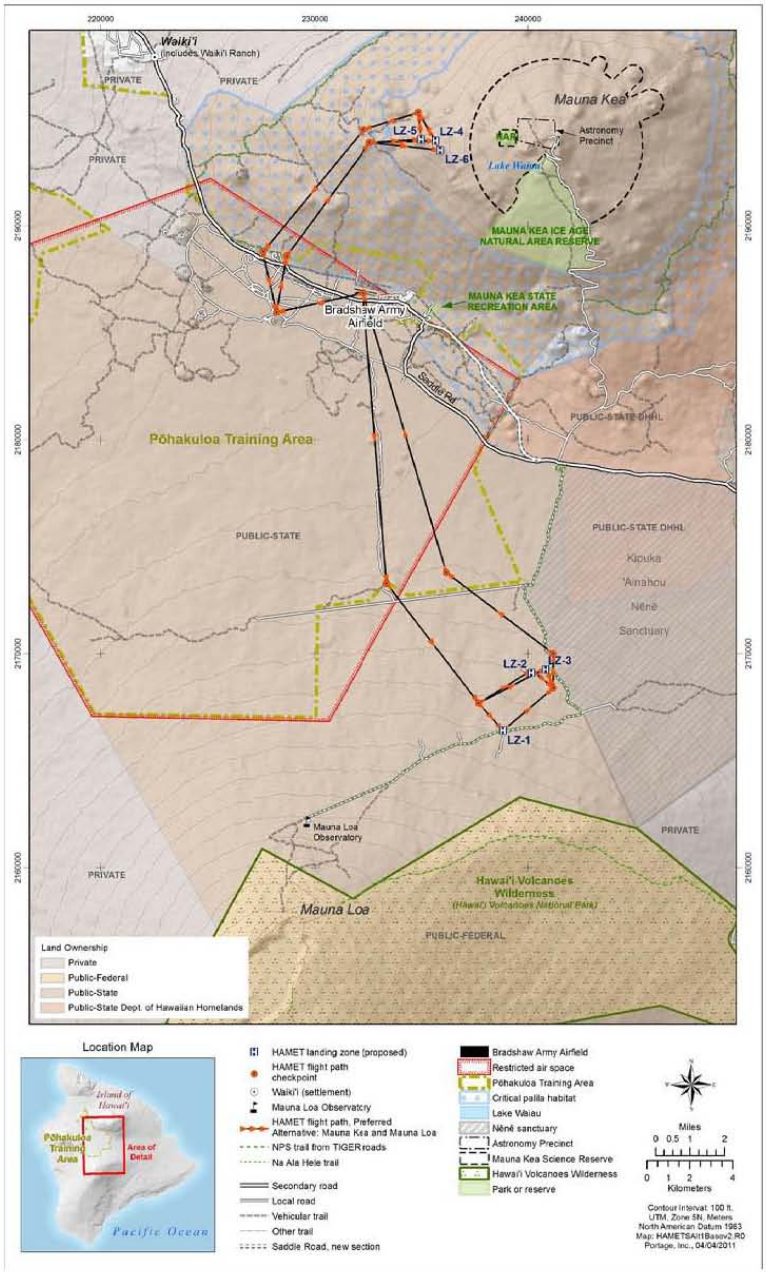


Mauna Loa APE

Enclosure 1



Mauna Kea APE



Flight paths for high altitude training

Enclosure 2

IMPC-HI-PWE March 2, 2011

MEMORANDUM FOR THE RECORD
SUBJECT: Survey of proposed landing zones on State Land on Mauna Loa (TMK: (3) 3-8-001:001) in Humuʻula Ahupuaʻa, North Hilo District, Hawaiʻi Island.

1. On February 14, 2011, Dr. Julie Taomia, PTA Archeologist, Ms. Lauren Morawski and Ms. Teresa Davan, USAG-HI Cultural Resources Specialists, travelled to Mauna Loa to conduct surveys of three proposed landing zones (LZ). The landing zones had been previously surveyed (Rumsey 2009), but rotor wash was not taken into account at that time. Therefore, in conjunction with the revision of the Environmental Assessment for the High Altitude Mountainous Environment Training proposed by the CAB, PTA Cultural Resources staff with assistance from O'ahu conducted surveys of each LZ covering 100 meters from the center of the LZ, the distance to which rotor wash would affect anything.
2. Landing Zone 2 is a leveled area in ʻaʻā lava of the 1899 Mauna Loa lava flow (Figure 1, 2 below). No historic properties were identified within 100 meters of the center of the LZ (Figures 3-8).
3. Landing Zone 1 is a leveled area in ʻaʻā lava along another finger of the 1899 Mauna Loa lava flow (Figures 1, 2). Pāhoehoe lava is present around the edges of the LZ. Several cavities were identified in this pāhoehoe; these were investigated, but no cultural resources were identified. An area 100 meters from the center of the LZ was surveyed, and no historic properties were identified within this area (Figures 9-11). Bulldozer tread marks were identified on some of the adjacent pāhoehoe (Figure 10).
4. Landing Zone 3 is a previously leveled area on the south side of the road to the Mauna Loa NOAA Observatory (Figure 12). The LZ is in ʻaʻā from the 1899 Mauna Loa lava flow, and the remnants of a wind sock are present across the road from the LZ. No historic properties were identified within the 100 meter survey area at this landing zone.
5. The use of the three previously existing landing zones on Mauna Loa will not have any effect on historic properties, as none are present in the vicinity of the landing zones.

Julie M. E. Taomia, Ph.D.
Archeologist
Environmental Office, PTA

Enclosure 3

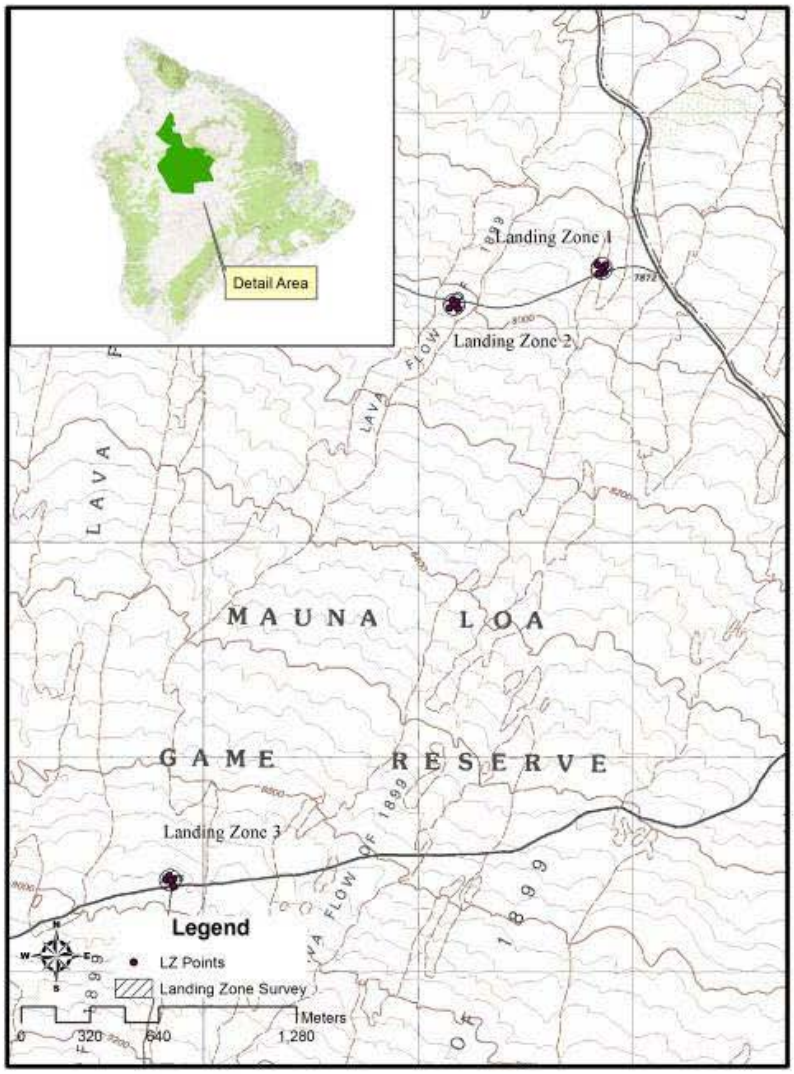


Figure 1. Overview of Mauna Loa Landing Zone locations

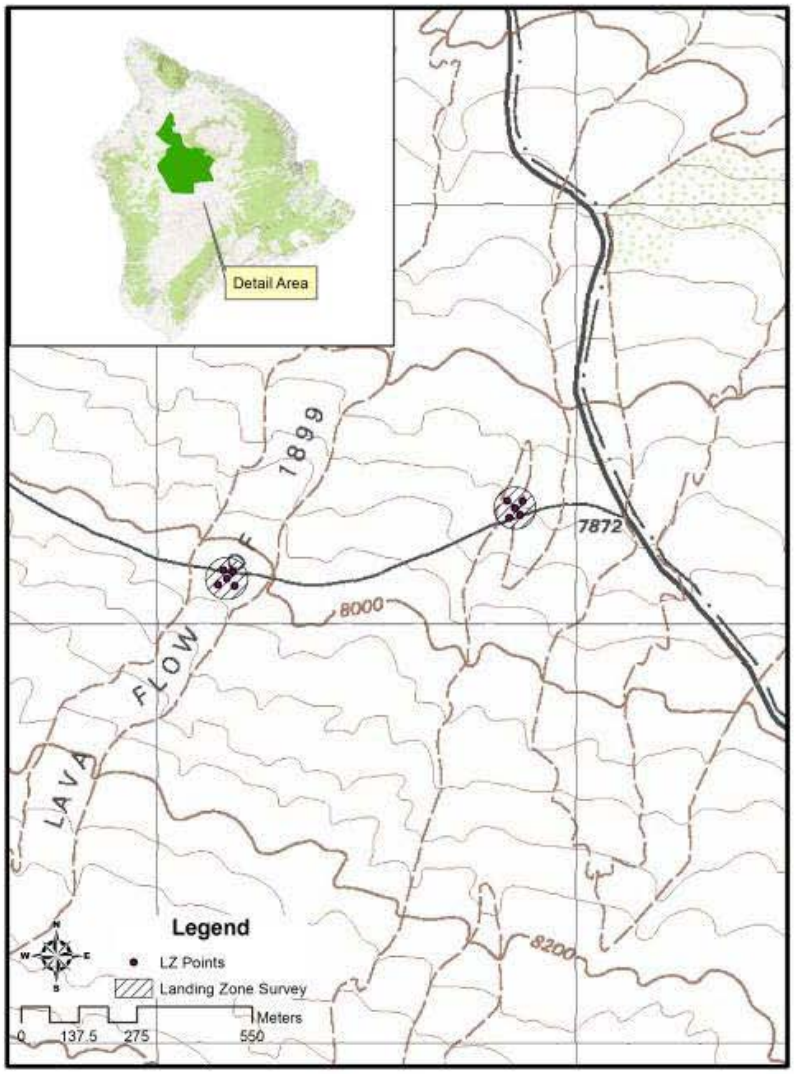


Figure 2. Detail of two lower level Mauna Loa Landing Zone Locations

Figure 3. LZ 2 View from the west edge beyond end of rotor wash area

Figure 4. LZ 2 View to south beyond end of rotor wash area

Figure 5. LZ 2 View to east beyond edge of LZ and rotor wash area

Figure 6. LZ 2 View to the west across LZ

Figure 7. LZ 2 View to the north across the LZ to the road

Figure 8. LZ 2 View to the north, beyond area of rotor wash influence.

Figure 9. LZ 1 view to northeast across LZ toward older lava.

Figure 10. LZ 1 view to southeast showing bulldozer tread marks, beyond edge of rotor wash.

Figure 11. LZ 1 Photo to the north showing road created by bulldozer, also edge of rotor wash area

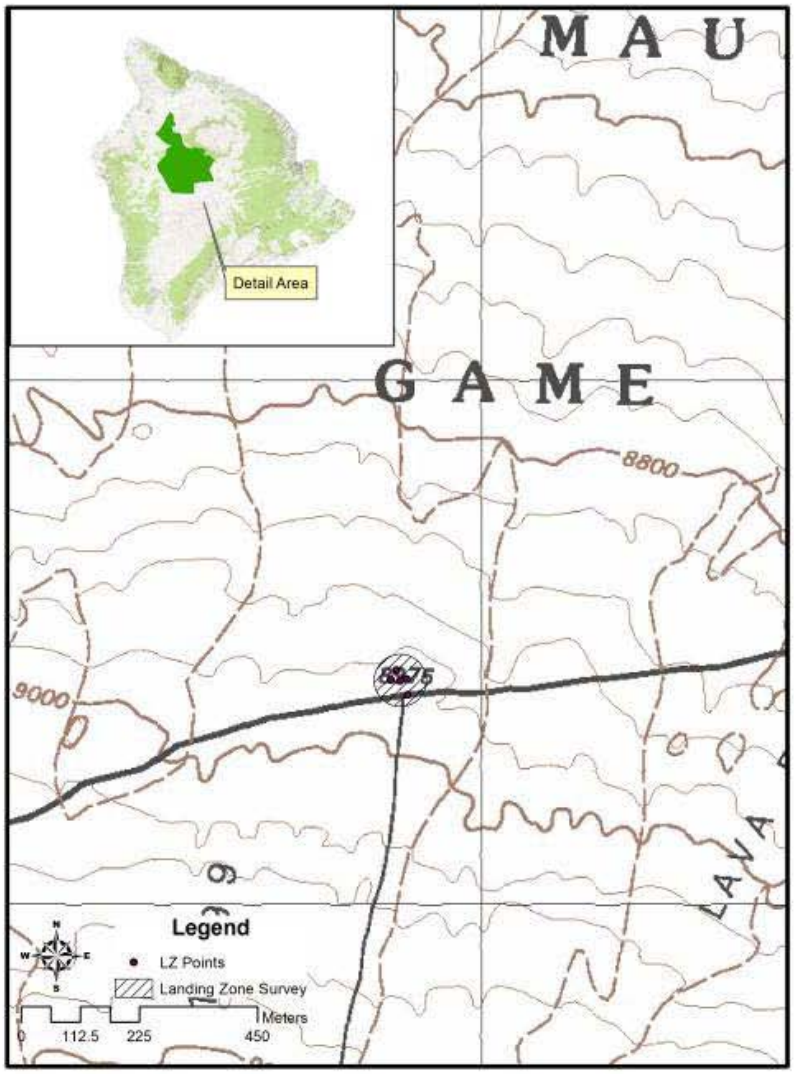


Figure 12. Detail location of LZ 3

Figure 12. LZ 3 view to the west showing rotor wash area

Figure 13. LZ 3 View to the west across the LZ

Figure 14. LZ 3 View to the north beyond the rotor wash area

Figure 15. LZ 3 view to the northwest beyond rotor wash area, poured concrete in foreground

Figure 16. View to the east beyond rotor wash area

Figure 17. View to the south showing road, power line, beyond extent of rotor wash

IMPC-HI-PWE **24 February 2011**

MEMORANDUM FOR THE RECORD

SUBJECT: Cultural Resources Reconnaissance Survey of Existing High Altitude Mountainous Environmental Training (HAMET) Landing Zones (LZ) on Mauna Kea, [TMK (3) 4-4-015:001, Kaʻohe Ahupuaʻa, Hāmākua District, Hawaiʻi Island.

1. On February 24, 2010, Mr. David Crowell and Ms. Kehaulani S. Kerr, Cultural Resources Program Manager and Cultural Resources Specialist at Pōhakuloa Training Area (PTA) and Ms. Dominique L. Cordy, intern with the U.S. Army Corps of Engineers (USACE), performed a cultural resources reconnaissance survey of the existing HAMET LZ locations on Mauna Kea (LZ-4, LZ-5, LZ-6). The HAMET LZ locations are located approximately 8km north of PTA on the northwestern flank of Mauna Kea, below the summit at approximately 11,000 – 12,000 fasl.

2. The HAMET LZ locations were previously surveyed in October and December 2003 (Godby and Head 2003a, Godby and Head 2003b). The previous efforts investigated only the 15m x 15m footprint of the LZs while the current investigation included a 100m area from the center of the LZs as the Area of Potential Effect (APE). The APE was established to account for rotor wash created by helicopters. The previous surveys did not identify any cultural resources within the 15m x 15m footprints of LZ4 and LZ-5. LZ-6 was designated LZ5a in the previous survey and a rock mound was identified approximately 50m south of the LZ (Godby and Head 2003b). The project area, APE, and results of the current survey are depicted in Figure 1. This report follows the order in which the LZs were visited.

3. Mr. Crowell, Ms. Kerr, and Ms. Cordy surveyed the APE at LZ-5 which is located on the top of an unnamed *puʻu* at 235019E, 2194049N. Two stacked rock features were identified near LZ-5 and were termed Rock Mound 1 and Rock Mound 2.

4. Rock Mound 1 is located between the southern edge of a large crater and the southern crest of the *puʻu* and overlooks the saddle region of Hawaiʻi Island. Rock Mound 1 is located approximately 144m south-southwest from LZ-5 and is just outside of the APE at 234950E, 2193928N. Rock Mound 1 is a pyramidal shaped stacked rock mound constructed in 5-7 courses of large and medium sized pieces of locally available rock with smaller rock and cobble infill. The area around the feature appears to have been cleared, ostensibly due the construction of Rock Mound 1.The feature measures approximately 2.65m x 1.75 m x 1.25m and is oriented roughly east-west. The feature is somewhat formally constructed with the rocks tightly placed and infilling with smaller rocks. Some of the rocks have tumbled from the top and the sides of the feature and lie immediately adjacent at the base (Figure 2).

Enclosure 4

5. Rock Mound 2is located between the northern edge of a large crater and the northern crest of the *pu'u*. T-022411-02 is located within the APE, approximately 82m east-southeast from LZ-5 and 181m northeast from Rock Mound 1 at 235099E, 2194029N. The feature is pyramidal shaped stacked rock mound constructed in 5-7 courses of large and medium sized pieces of locally available rock with some smaller rock infill, but less infilling than present at Rock Mound 1. Additionally, Rock Mound 2 has a more rectangular and less pyramidal shape than Rock Mound 1, but is wider at the base than at the top. The feature displays somewhat formal construction characteristics, with tightly placed rocks and some evidence of a faced profile on the north side of the feature. The area around the feature shows evidence of clearing due to the construction of the mound. Rock Mound 2 measures approximately 2.55m x 1.67 x 1.12m and is oriented roughly east-west. A few of the rocks have tumbled from the sides and the top of the feature and lie immediately adjacent at the base (Figure 3-Figure 4).

6. Mr. Crowell, Ms. Kerr, and Ms. Cordy next surveyed the APE at LZ-6 which is located on the top of another unnamed *pu'u* located approximately 1023m southeast of LZ-5 at 235702E, 2193975N. One stacked rock feature was identified near LZ-6 and was termed Rock Mound 3. This feature was previously identified in Godby and Head (2003b) and described as a rock mound constructed with local cobbles and boulders with faced sides on the north and the east. The current survey identified Rock Mound 3 located within the APE, approximately 56m east-southeast from LZ-6 at 235709E, 2193881N. The feature is a pyramidal shaped stacked rock mound constructed in 6-8 courses of large and medium pieces of locally available rock with smaller rock and cobble infill. Rock Mound 3 is fairly formally constructed with tightly placed rocks and infilling. The faced profiles discussed in the previous survey were not readily apparent to the current survey team. Rock Mound 2 displayed a more clearly faced profile on the north elevation than any possible facing observed at Rock Mound 3. The area around the feature was cleared during the construction of the mound. Rock Mound 3 is approximately 2.13m x 1.37m x 1.35m and is oriented roughly north south. Rock Mound 1 and Rock Mound 2 are clearly visible from Rock Mound 3 (Figure 5 - Figure 6).

7. Mr. Crowell, Ms. Kerr, and Ms. Cordy final survey area was the APE at LZ-4 which is located on a relatively flat area approximately 687m east of LZ-5 and 481 m north-northwest of LZ-6 at 235702E, 2193975N. One small, single course diamond shaped rock alignment feature was identified near LZ-4 and was termed Rock Alignment 1. Rock Alignment 1is located within the APE, approximately 97m south from LZ-4 at 235954E, 2193517N. The feature is constructed of small and medium pieces of locally available rock with some cobble infilling. Rock Alignment 1 does not display formal construction characteristics, with the rocks simply sitting on top of the ground without being tightly placed or imbedded in the soil. Rock Alignment 1 is approximately 1.63m x 1.11m x .021m and is oriented roughly northwest-southeast (Figure 7 - Figure 8).

David M. Crowell
Cultural Resources Program Manger
Environmental Office, PTA

Godby, William and James Head

2003 Trip Report for the Archaeological Survey of Proposed Helicopter Landing Areas (LZ-5, LZ-5a, and LZ-6) for High Altitude Training from December 8, 2003 to December 12, 2003. On File at PTA.

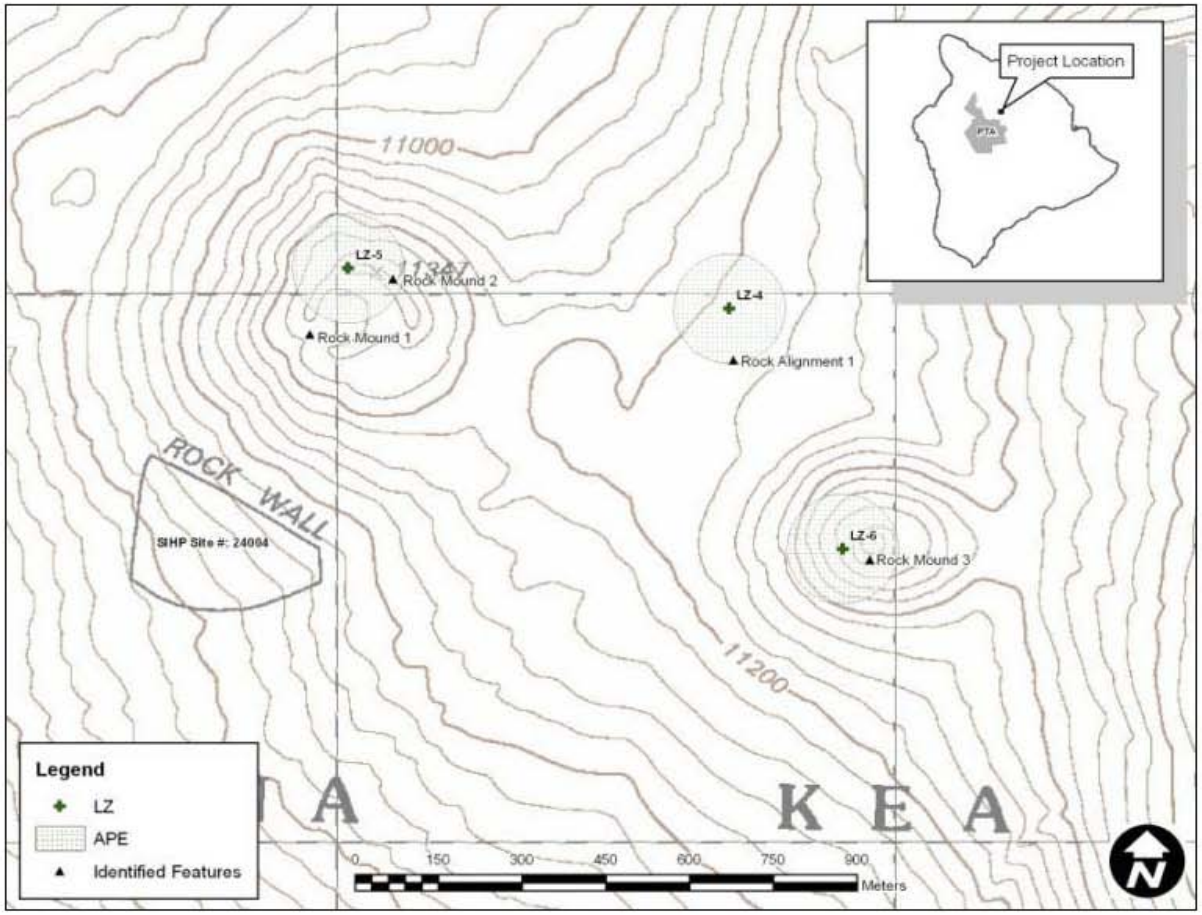


Figure 1. Location of LZs, APE, and identified cultural resources

Figure 2. Rock Mound 1 near LZ5, looking south

Figure 3. Rock Mound 2 near LZ5, looking south

Figure 4. View from top of Rock Mound 2 to Rock Mound 1 near LZ5, looking south

Figure 5. Rock Mound 3 near LZ 6, looking west

Figure 6. Rock Mound 3 near LZ6 with view of Rock Mounds 1 and 2 near LZ5, looking west

Figure 7. Rock Alignment 1 near LZ4, looking east

Figure 8. Rock Alignment 1 near LZ4, looking west-southwest

IMPC-HI-PWE **24 March 2011**

MEMORANDUM FOR THE RECORD

SUBJECT: Archaeological Monitoring of Rock Mounds near Landing Zones 5 and 6 (LZ-5 and LZ-6) of the High Altitude Mountainous Environmental Training (HAMET) LZ's on Mauna Kea, [TMK (3) 4-4-015:001, Kaʻohe Ahupuaʻa, Hāmākua District, Hawaiʻi Island.

1. On March 24, 2011 , Mr. David Crowell and Ms. Kehaulani S. Kerr, Cultural Resources Program Manager and Cultural Resources Specialist at Pōhakuloa Training Area (PTA), performed monitoring of the rock mounds (Rock Mounds 1-3) identified near LZ-5 and LZ-6 HAMET locations on Mauna Kea. The LZ-5 and LZ-6 HAMET locations are located approximately 8km north of PTA on the northwestern flank of Mauna Kea, below the summit at approximately 11,000 – 12,000 fasl.

2. The rock mounds at LZ-5 and LZ-6 HAMET locations were previously identified in December 2003 (Godby and Head 2003) and February 2011 (Crowell 2011). The project area, APE, and results of the 2011 (Crowell) survey are depicted in Figure 1. Rock Alignment 1 near LZ-4 was not identified for monitoring. Monitoring of Rock Mound 1 and 2 near LZ-5 and Rock Mound 3 near LZ-6 was performed on March 24, 2011 during a break in the U.S. Army Combat Aviation Brigade (CAB) training that used the HAMET LZ's from March 21 – April 1, 2011. The monitoring is being performed to ascertain whether the HAMET training has any potential effects on the rock mounds. Follow up monitoring of the Rock Mounds will also be performed on April 4, 2011 at the conclusion of CAB training.

3. Monitoring consisted of a visual inspection of each rock mound and the immediate vicinity around each mound. Locations of photographs from the 02/24/11 survey were identified (Figure 2, Figure 7, and Figure 12) and new photographs were taken from those locations to document any potential effects to the mounds. Additional photographs were taken of the remaining profiles of each rock mound in order to more fully document the mounds and to provide additional baseline data from which monitoring of potential effects may be performed.

4. Mr. Crowell and Ms. Kerr began archaeological monitoring at Rock Mound 1 near LZ-5. Rock Mound 1 was observed to be partially collapsed during the February 24, 2011 survey with several rocks having tumbled from the mound especially on the north, west, and south profiles. On March 24, 2011 no additional tumbled rocks or collapse of the mound was observed and it appeared to be intact from the previous visit with no adverse effects from the HAMET training (Figure 2 - Figure 3). The east, south, and west profiles were also photographed (Figure 4 - Figure 6) for comparison purposes.

Enclosure 5

5. Rock Mound 2 near LZ-5 was the next location that was monitored. During the February 24, 2011 survey Rock Mound 2 was observed as being partially collapsed, with some rocks that had tumbled from the north and west profiles, but not as extensively as Rock Mound 1. On March 24, 2011 no additional tumbled rocks or collapse of the mound was observed and it appeared to be intact from the previous visit with no adverse effects from the HAMET training (Figure 7 - Figure 8). The east, south, and west profiles were also photographed (Figure 9 - Figure 11) for comparison purposes.

6. Rock Mound 3 near LZ-6 was the final location that was monitored. During the February 24, 2011 survey Rock Mound 3 was observed as being slightly collapsed, with some rocks that had tumbled from the south profile. On March 24, 2011 no additional tumbled rocks or collapse of the mound was observed and it appeared to be intact from the previous visit with no adverse effects from the HAMET training (Figure 12 - Figure 13). The south, west, and north profiles were also photographed (Figure 14 - Figure 16) for comparison purposes.

David M. Crowell
Cultural Resources Program Manger
Environmental Office, PTA

References

Godby, William and James Head

2003 Trip Report for the Archaeological Survey of Proposed Helicopter Landing Areas (LZ-5, LZ-5a, and LZ-6) for High Altitude Training from December 8, 2003 to December 12, 2003. On File at PTA.

Crowell, David M.

2011 Cultural Resources Reconnaissance Survey of Existing High Altitude Mountainous Environmental Training (HAMET) Landing Zones (LZ) on Mauna Kea, [TMK (3) 4-4-015:001, Ka‘ohe Ahupua‘a, Hāmākua District, Hawai‘i Island. On File at PTA

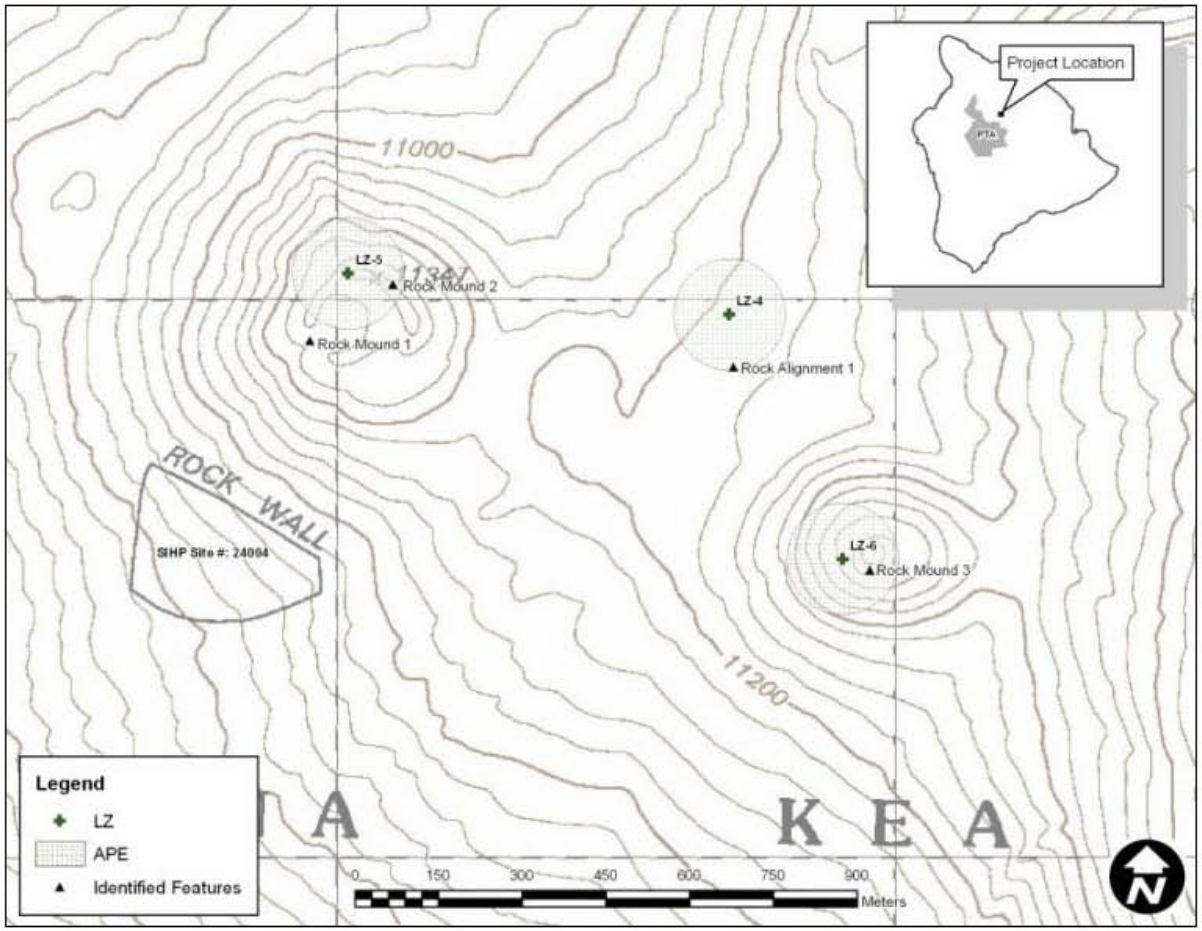


Figure 1. Location of LZs, APE, and identified cultural resources

Figure 2. Rock Mound 1 near LZ-5, looking south, photo taken on 02/24/11

Figure 3. Rock Mound 1 near LZ-5, looking south, photo taken on 03/24/11

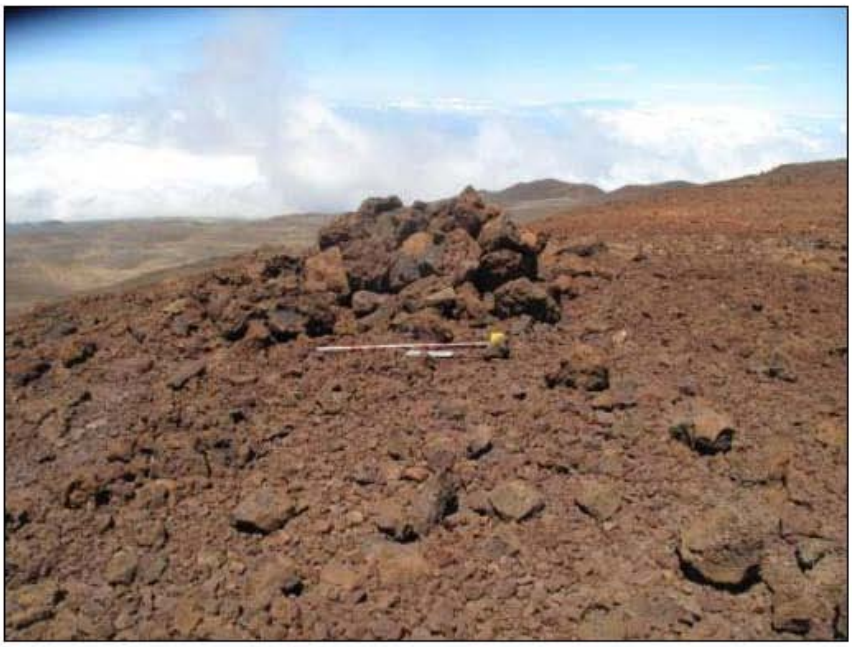


Figure 4. Rock Mound 1 near LZ5, looking west, photo taken on 03/24/11

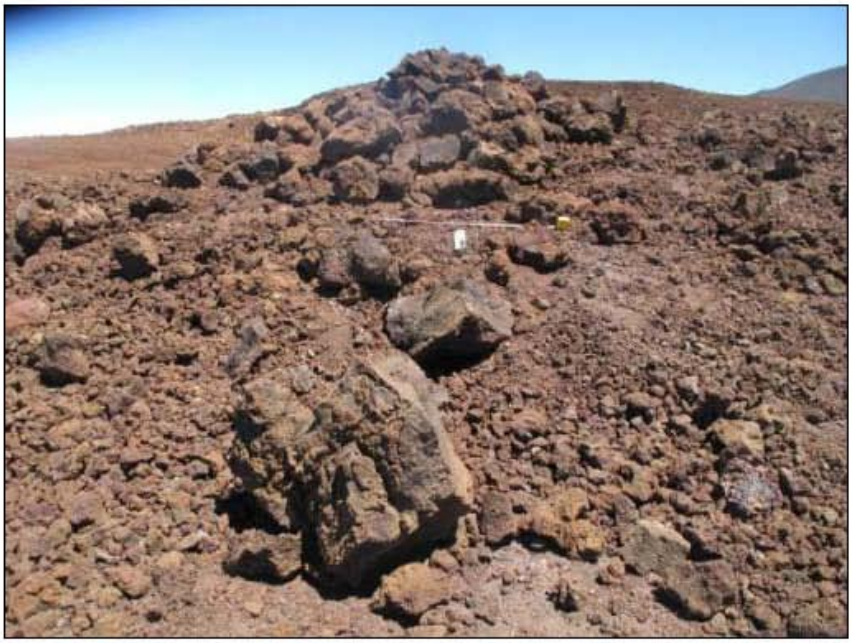


Figure 5. Rock Mound 1 near LZ5, looking north, photo taken on 03/24/11

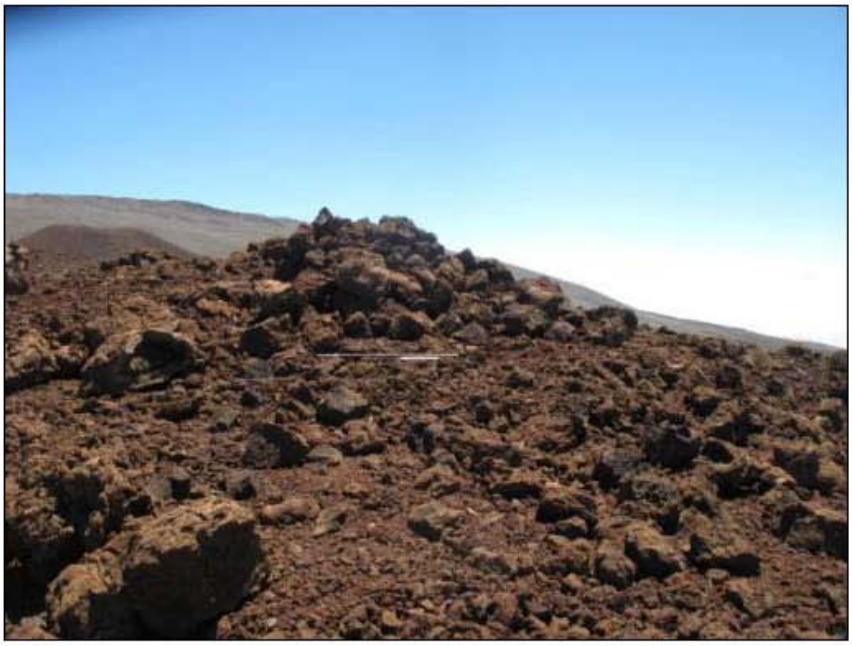


Figure 6. Rock Mound 1 near LZ5, looking east, photo taken on 03/24/11

Figure 7. Rock Mound 2 near LZ5, looking south, photo taken on 02/24/11

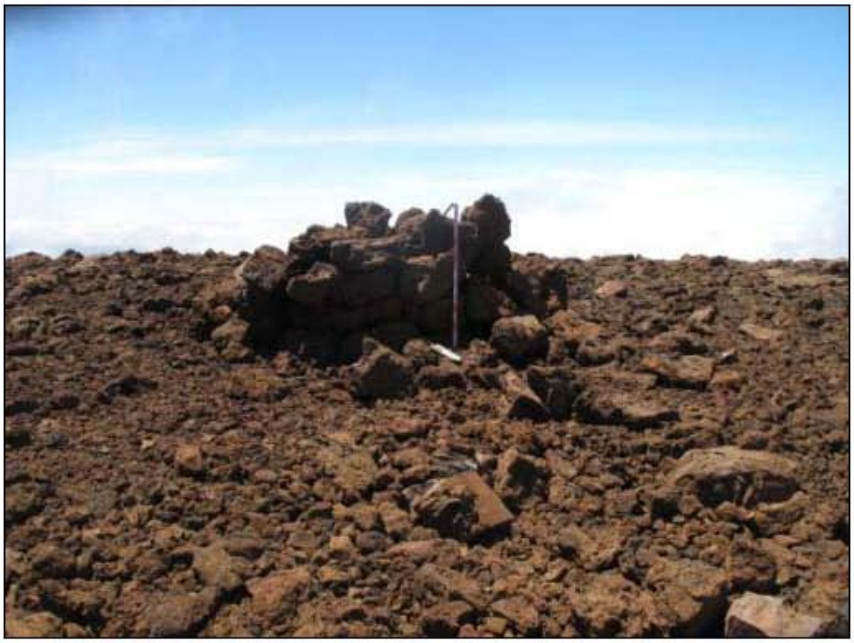


Figure 8. Rock Mound 2 near LZ5, looking south, photo taken on 03/24/11

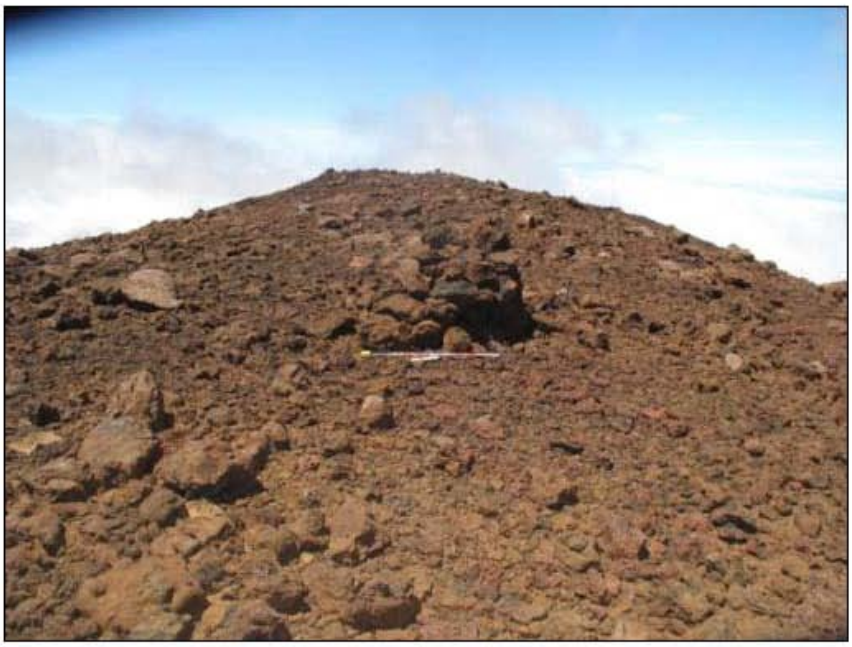


Figure 9. Rock Mound 2 near LZ5, looking west, photo taken on 03/24/11

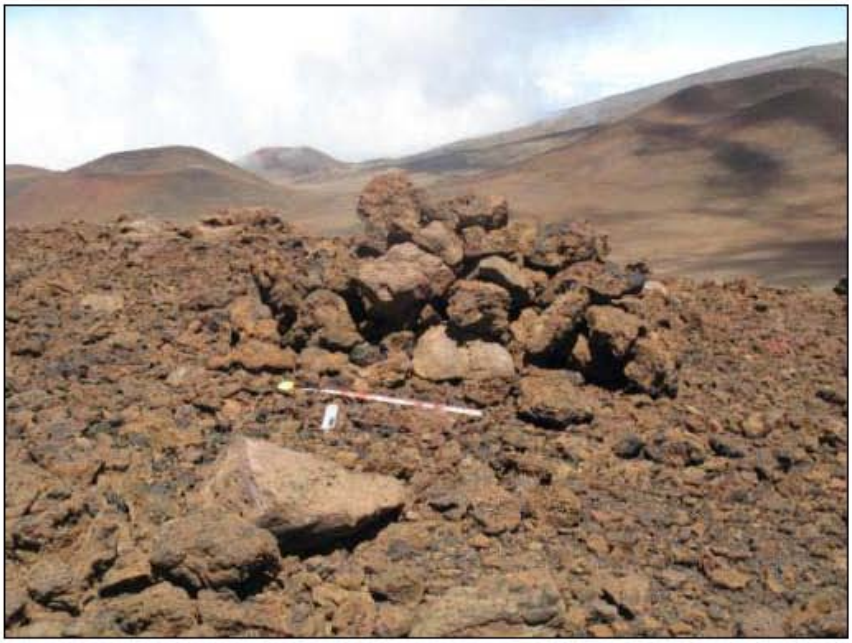


Figure 10. Rock Mound 2 near LZ-5, looking north, photo taken on 03/24/11

Figure 11. Rock Mound 2 near LZ5, looking east, photo taken on 03/24/11

Figure 12. Rock Mound 3 near LZ-6, looking west, photo taken on 02/24/11

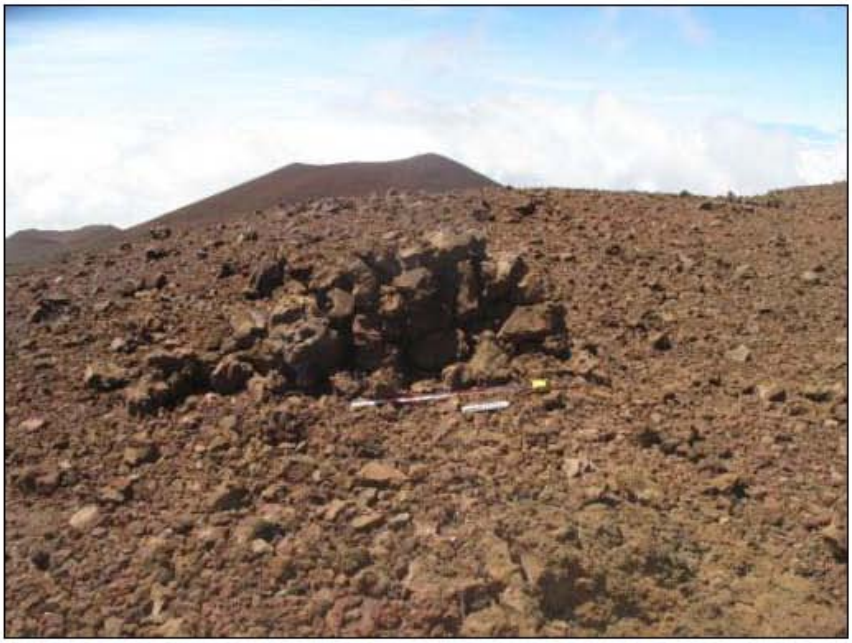


Figure 13. Rock Mound 3 near LZ-6, looking west, photo taken on 03/24/11

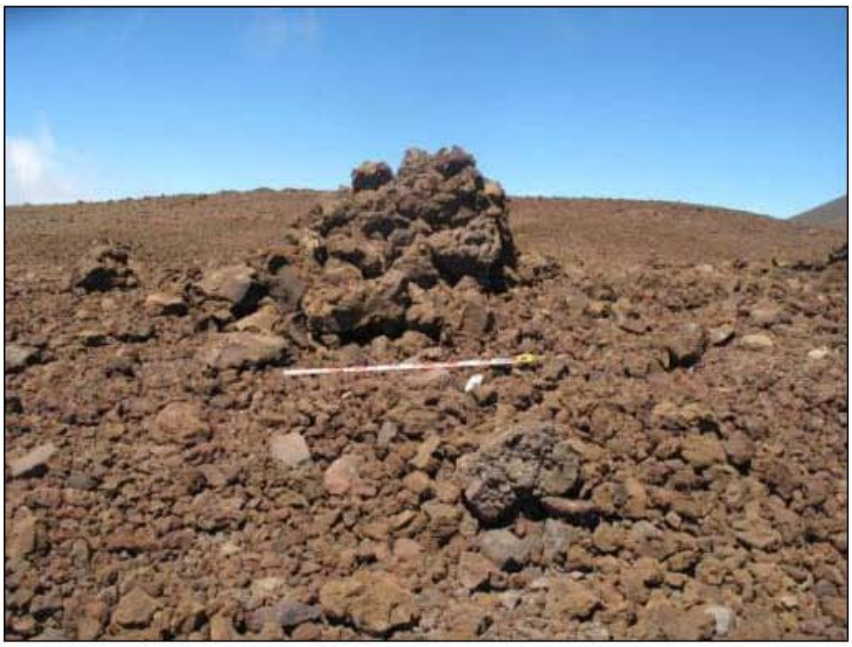


Figure 14. Rock Mound 3 near LZ-6, looking north, photo taken on 03/24/11

Figure 15. Rock Mound 3 near LZ-6, looking east, photo taken on 03/24/11

Figure 16. Rock Mound 3 near LZ-6, looking south, photo taken on 03/24/11

IMPC-HI-PWE **04 April 2011**

MEMORANDUM FOR THE RECORD

SUBJECT: Archaeological Monitoring of Rock Mounds near Landing Zones 5 and 6 (LZ-5 and LZ-6) of the High Altitude Mountainous Environmental Training (HAMET) LZ's on Mauna Kea, [TMK (3) 4-4-015:001, Kaʻohe Ahupuaʻa, Hāmākua District, Hawaiʻi Island.

1. On April 4, 2011 , Mr. David Crowell and Ms. Kehaulani S. Kerr, Cultural Resources Program Manager and Cultural Resources Specialist at Pōhakuloa Training Area (PTA), performed monitoring of the rock mounds (Rock Mounds 1-3) identified near LZ-5 and LZ-6 HAMET locations on Mauna Kea. The LZ-5 and LZ-6 HAMET locations are located approximately 8km north of PTA on the northwestern flank of Mauna Kea, below the summit at approximately 11,000 – 12,000 fasl.

2. The rock mounds at LZ-5 and LZ-6 HAMET locations were previously identified in December 2003 (Godby and Head 2003) and February 2011 (Crowell 2011). The project area, APE, and results of the 2011 (Crowell) survey are depicted in Figure 1. Rock Alignment 1 near LZ-4 was not identified for monitoring. Monitoring of Rock Mound 1 and 2 near LZ-5 and Rock Mound 3 near LZ-6 was performed on March 24, 2011 during a break in the U.S. Army Combat Aviation Brigade (CAB) training episode using the HAMET LZ's. The monitoring is being performed to ascertain whether the HAMET training has any potential effects on the rock mounds. Follow up monitoring of the Rock Mounds was also performed on April 4, 2011 at the conclusion of CAB training.

3. Monitoring consisted of a visual inspection of each rock mound and the immediate vicinity around each mound. Locations of photographs from the February 24, 2011 survey were identified (Figure 2, Figure 11, and Figure 18) and new photographs were taken from those locations to document any potential effects to the mounds. Additional photographs were taken of the remaining profiles of each rock mound in order to more fully document the mounds and to provide additional baseline data from which monitoring of potential effects may be performed.

4. Mr. Crowell and Ms. Kerr began archaeological monitoring at Rock Mound 1 near LZ-5. Rock Mound 1 was observed to be partially collapsed during the February 24, 2011 survey with several rocks having tumbled from the mound especially on the north, west, and south profiles. On April 4, 2011 no additional tumbled rocks or collapse of the mound was observed and it appeared to be intact from the previous visit with no adverse effects from the HAMET training (Figure 2 -Figure 4). The east, south, and west profiles were also photographed (Figure 5 - Figure 10) and compared with the photographs from the March 24, 2011 monitoring episode. No adverse effects were observed on any side of Rock Mound 1.

Enclosure 6

5. Rock Mound 2 near LZ-5 was the next location that was monitored. During the February 24, 2011 survey Rock Mound 2 was observed as being partially collapsed, with some rocks that had tumbled from the north and west profiles, but not as extensively as Rock Mound 1. On April 4, 2011 no additional tumbled rocks or collapse of the mound was observed and it appeared to be intact from the previous visit with no adverse effects from the HAMET training (Figure 11 - Figure 13). The east, south, and west profiles were also photographed (Figure 14 - Figure 17) and compared with the photographs from the March 24, 2011 monitoring episode. No adverse effects were observed on any side of Rock Mound 2.

6. Rock Mound 3 near LZ-6 was the final location that was monitored. During the February 24, 2011 survey Rock Mound 3 was observed as being slightly collapsed, with some rocks that had tumbled from the south profile. On April 4, 2011 no additional tumbled rocks or collapse of the mound was observed and it appeared to be intact from the previous visit with no adverse effects from the HAMET training (Figure 18 - Figure 20). The south, west, and north profiles were also photographed (Figure 21- Figure 26) and compared with the photographs from the March 24, 2011 monitoring episode. No adverse effects were observed on any side of Rock Mound 3.

David M. Crowell
Cultural Resources Program Manger
Environmental Office, PTA

References

Godby, William and James Head

2003 Trip Report for the Archaeological Survey of Proposed Helicopter Landing Areas (LZ-5, LZ-5a, and LZ-6) for High Altitude Training from December 8, 2003 to December 12, 2003. On File at PTA.

Crowell, David M.

2011 Cultural Resources Reconnaissance Survey of Existing High Altitude Mountainous Environmental Training (HAMET) Landing Zones (LZ) on Mauna Kea, [TMK (3) 4-4-015:001, Ka‘ohe Ahupua‘a, Hāmākua District, Hawai‘i Island. On File at PTA

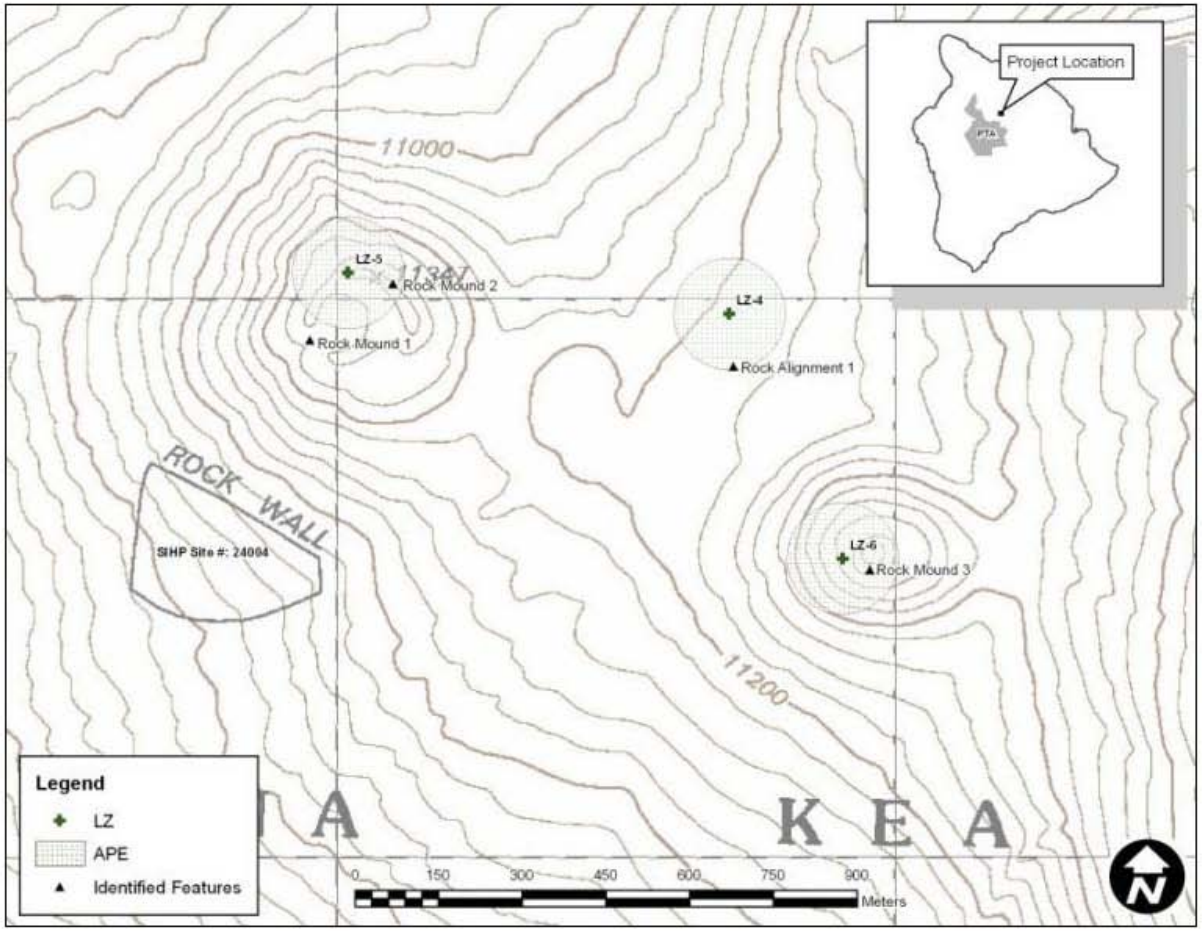


Figure 1. Location of LZs, APE, and identified cultural resources

Figure 2. Rock Mound 1 near LZ-5, looking south, photo taken on 02/24/11

Figure 3. Rock Mound 1 near LZ-5, looking south, photo taken on 03/24/11

Figure 4. Rock Mound 1 near LZ-5, looking south, photo taken on 04/04/11

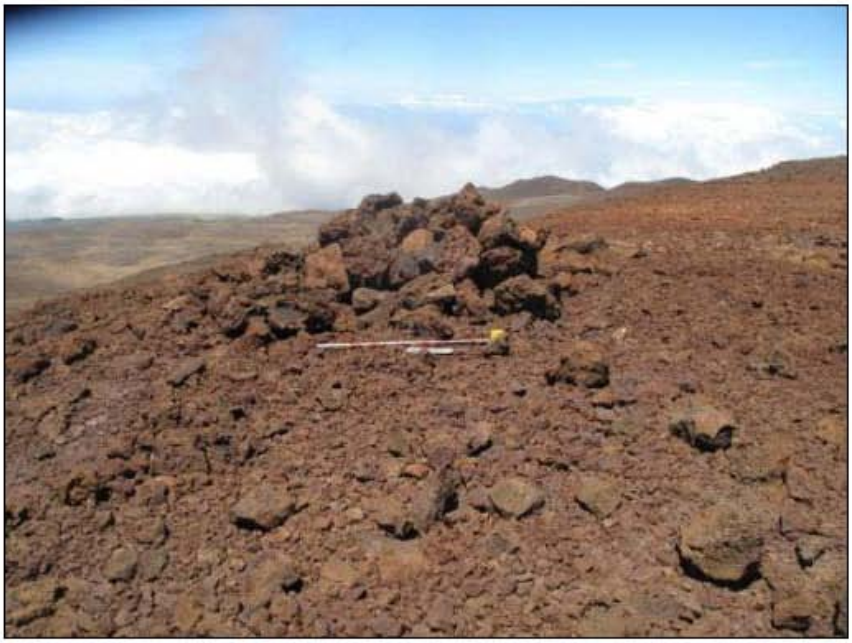


Figure 5. Rock Mound 1 near LZ5, looking west, photo taken on 03/24/11

Figure 6. Rock Mound 1 near LZ-5, looking west, photo taken on 04/04/11

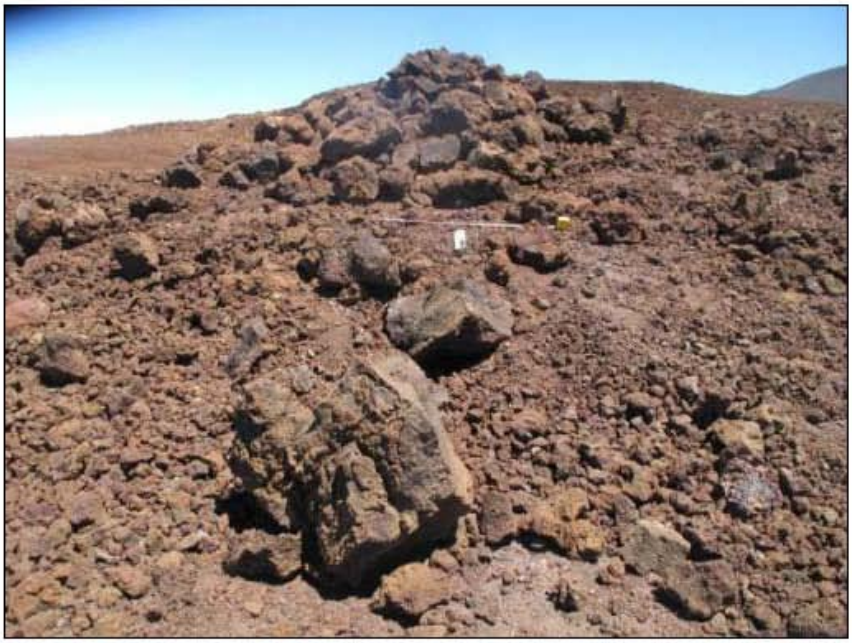


Figure 7. Rock Mound 1 near LZ5, looking north, photo taken on 03/24/11

Figure 8. Rock Mound 1 near LZ-5, looking north, photo taken on 04/04/11

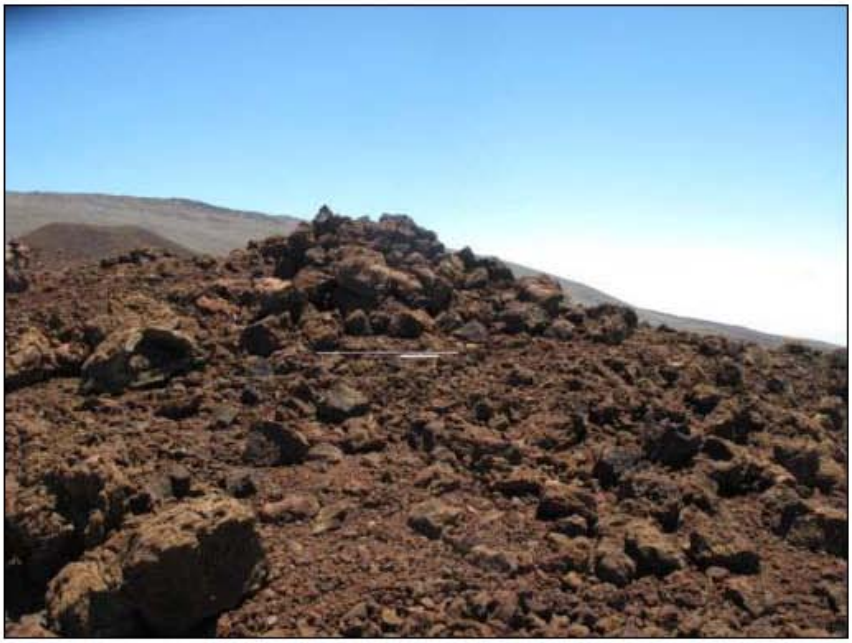


Figure 9. Rock Mound 1 near LZ5, looking east, photo taken on 03/24/11

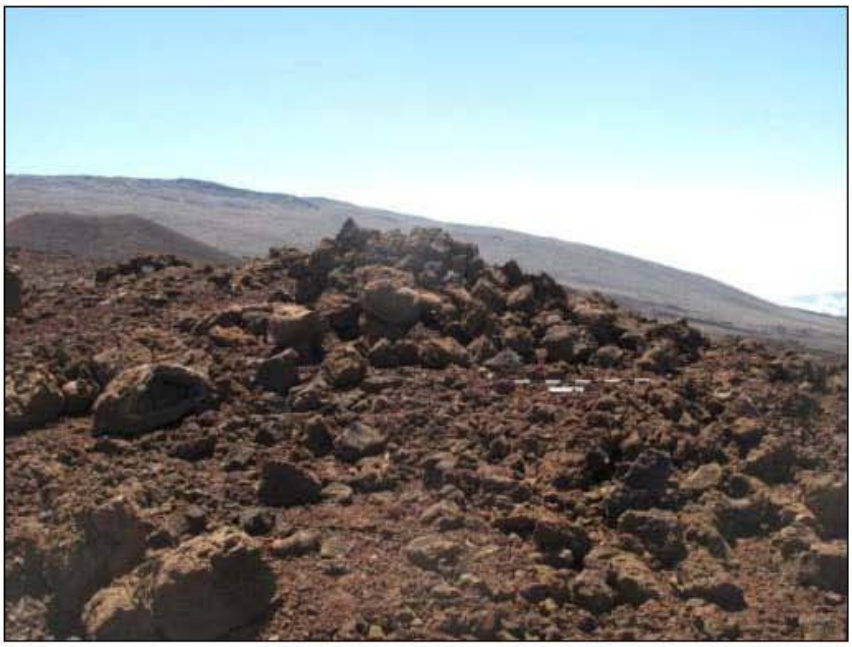


Figure 10. Rock Mound 1 near LZ-5, looking east, photo taken on 04/04/11

Figure 11. Rock Mound 2 near LZ5, looking south, photo taken on 02/24/11

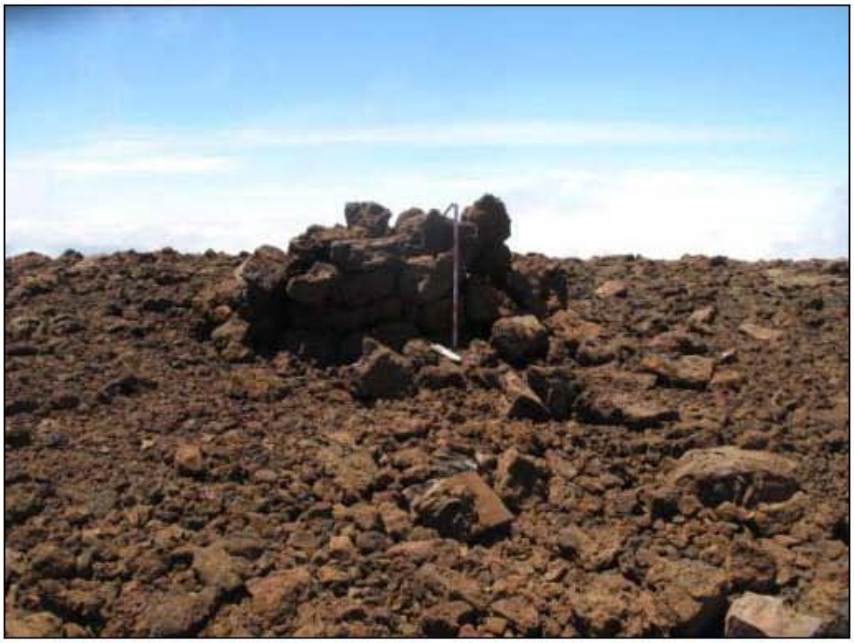


Figure 12. Rock Mound 2 near LZ5, looking south, photo taken on 03/24/11

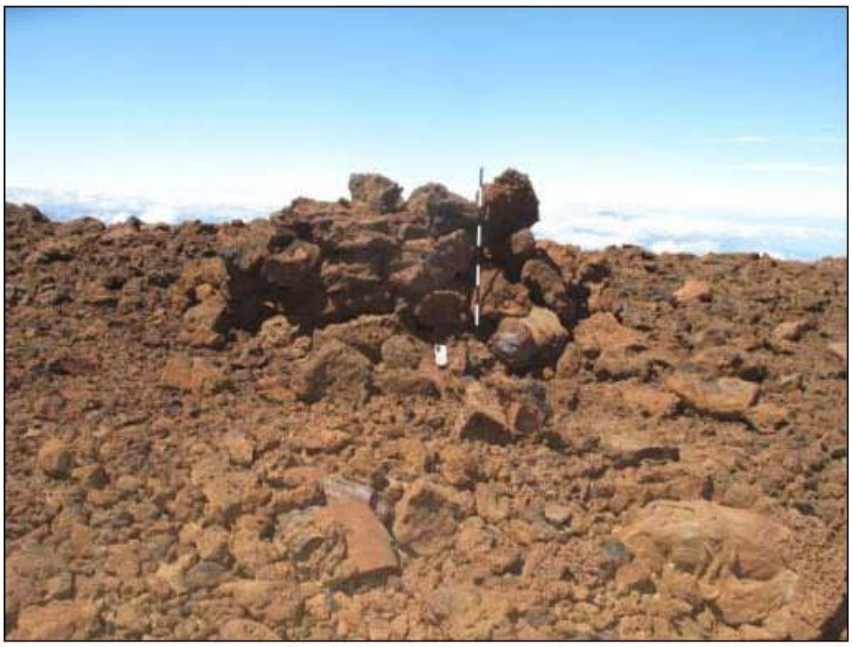


Figure 13. Rock Mound 2 near LZ5, looking south, photo taken on 04/04/11

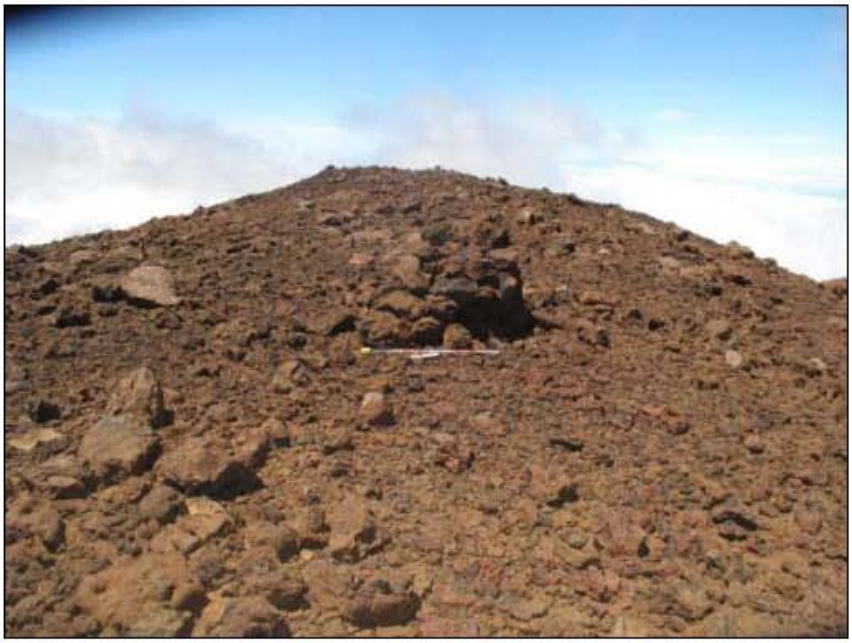


Figure 14. Rock Mound 2 near LZ5, looking west, photo taken on 03/24/11

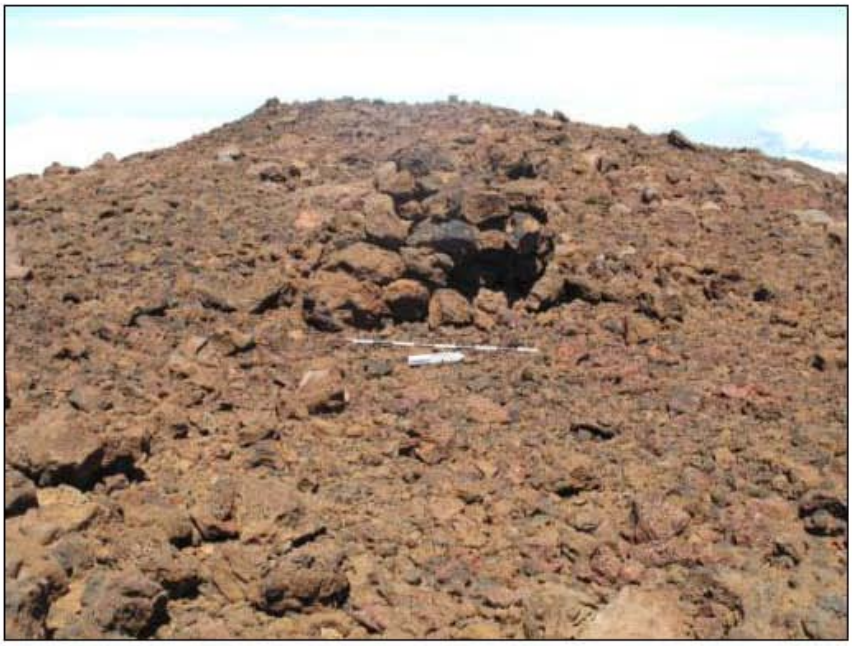


Figure 15. Rock Mound 2 near LZ5, looking west, photo taken on 04/04/11

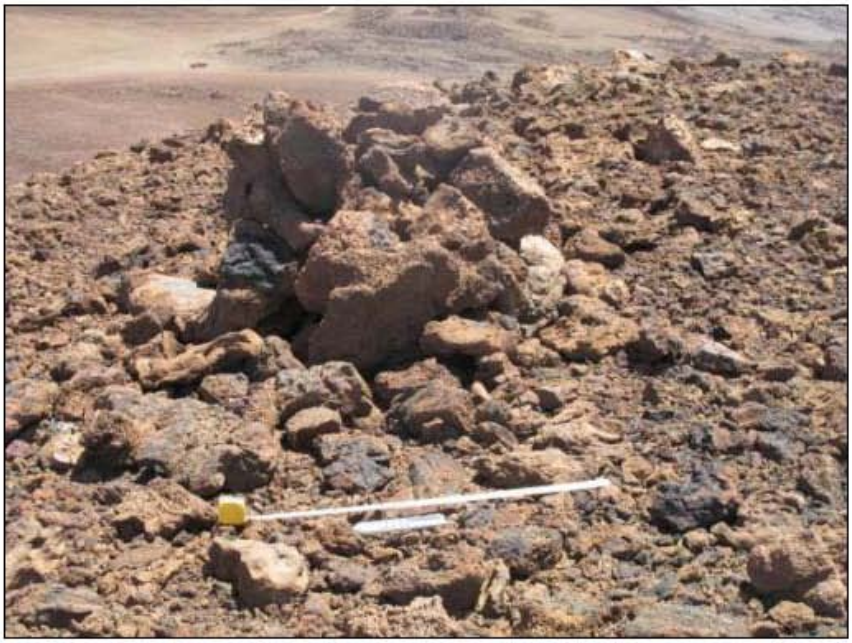


Figure 16. Rock Mound 2 near LZ5, looking east, photo taken on 03/24/11

Figure 17. Rock Mound 2 near LZ5, looking east, photo taken on 04/04/11

Figure 18. Rock Mound 3 near LZ-6, looking west, photo taken on 02/24/11

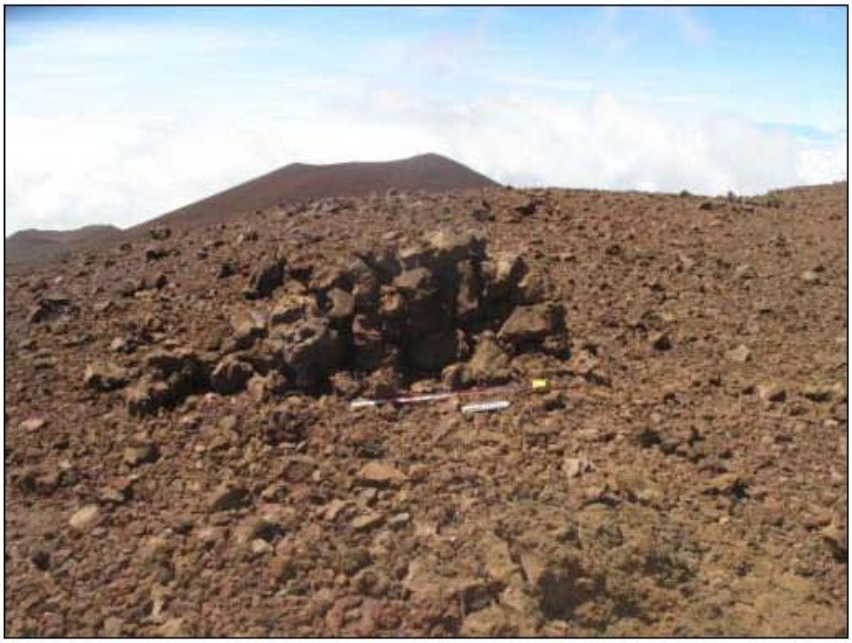


Figure 19. Rock Mound 3 near LZ-6, looking west, photo taken on 03/24/11

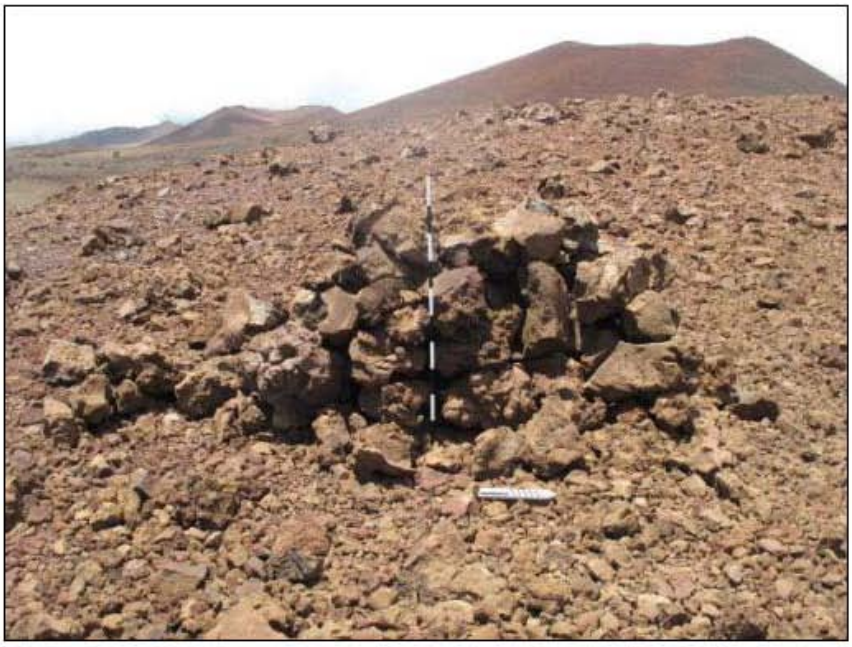


Figure 20. Rock Mound 3 near LZ-6, looking west, photo taken on 04/04/11

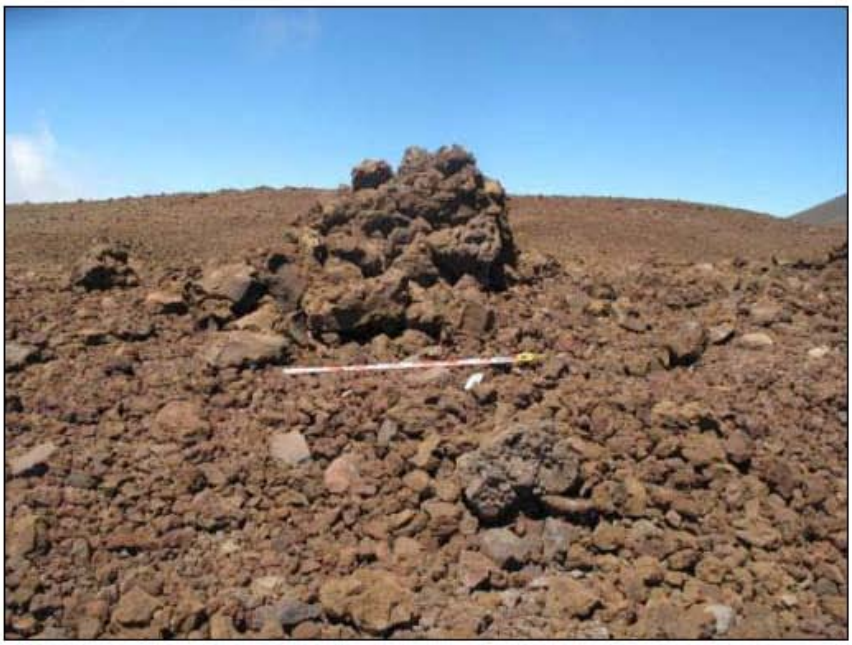


Figure 21. Rock Mound 3 near LZ-6, looking north, photo taken on 03/24/11

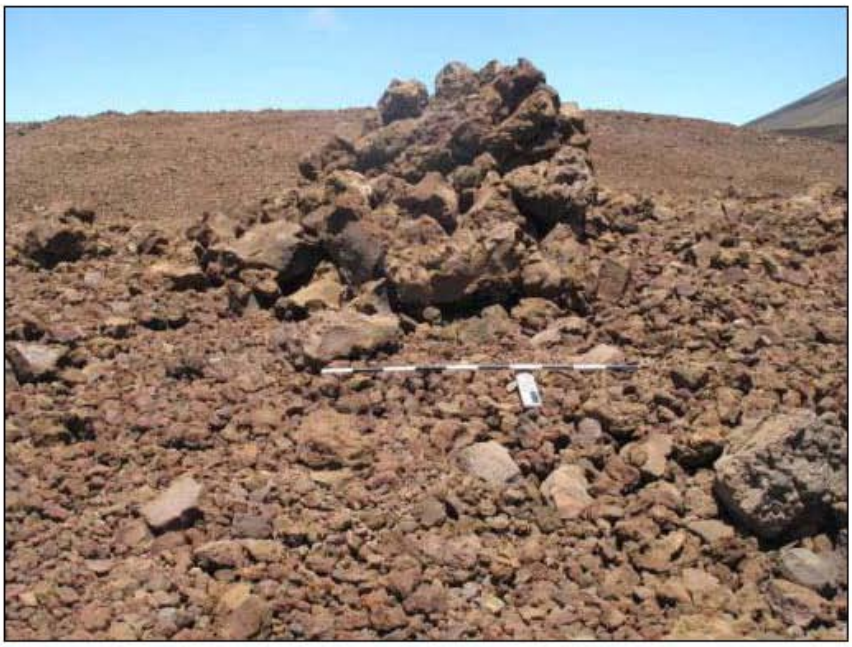


Figure 22. Rock Mound 3 near LZ-6, looking north, photo taken on 04/04/11

Figure 23. Rock Mound 3 near LZ-6, looking east, photo taken on 03/24/11

Figure 24. Rock Mound 3 near LZ-6, looking east, photo taken on 04/04/11

Figure 25. Rock Mound 3 near LZ-6, looking south, photo taken on 03/24/11

Figure 26. Rock Mound 3 near LZ-6, looking south, photo taken on 04/04/11

IMPC-HI-PWE **22 March 2011**

MEMORANDUM FOR THE RECORD

SUBJECT: Cultural Resources Reconnaissance Survey for noise monitor placements on Mauna Kea, [TMK (3) 4-4-015:001 & TMK (3) 4-4-015:09] Ka'ohe Ahupua'a, Hāmākua District, Hawai'i Island.

1. On March 19th & 20th, 2011, Mr. David Crowell and Ms. Kehaulani Kerr, Cultural Resources Program Manager and Cultural Resources Specialist at Pōhakuloa Training Area (PTA), conducted a cultural resources reconnaissance survey of six locations on Mauna Kea to monitor the noise associated with the high altitude training at the existing HAMET LZ locations on Mauna Kea (LZ-4, LZ-5, LZ-6). The HAMET LZ locations are located approximately 8km north of PTA on the northwestern flank of Mauna Kea, below the summit at approximately 11,000 – 12,000 feet above sea level (fasl). The noise monitors (1-3) covers approximately 850 *hectares* and is located to the northwest of the cantonment area at PTA. The noise monitors (4-6) covers approximately 150 *hectares* and is located to the western side of the summit on Mauna Kea (figure 1).

2. The HAMET LZ locations were previously surveyed in October and December 2003 (Godby and Head 2003a, Godby and Head 2003b). The previous efforts investigated only the 15m x 15m footprint of the LZs while the current investigation included a 100m area from the center of the LZs as the Area of Potential Effect (APE). On February 24th, 2010, PTA cultural resources (CR) staff preformed the cultural resources reconnaissance survey for the existing HAMET LZ locations on Mauna Kea. On March 19th, 2011, Mr. Crowell and Ms. Kerr joined Don Weir (Ranger- Office of Mauna Kea Management), David Lodman and Jim Jackson (Portage, Inc.) at the visitor center and proceeded to the summit of Mauna Kea to install noise monitors (4-6). The noise control study will collect scientific data that shows if the archaeological sites in the area will be impacted by the high altitude training as well as study the impacts from recreational uses by the visiting public and hunters. On March 20th, 2010, Mr. Crowell and Ms. Kerr along with the contractors from Portage Inc. installed noise monitors (1-3). The noise monitors (1-3) located in Ka'ohe Game Management Area have been strategically place within the critical *Palila* habitat to study the effect of noise pollution to their environment.

3. Noise monitor #1 is located 470m north of Saddle road at the approximate elevation of 6000 fasl (0228474E, 2189226N) to the north side of saddle road. No archaeological sites were found within the area (figure 2).

Enclosure 7

4. Noise Monitor # 2 1 is located about 200m to the north of Pu'uokauha at the approximate elevation of 8000 fasl (0231310E, 2191370N). No archaeological sites were found within the area. Mr. Crowell and Ms. Kerr discovered three Palila during the placement of the noise monitor this day. Upon returning to the cantonment area at PTA, the natural resources section at PTA was notified of the discovery (figure 3).

5. Noise monitor #3 is located about 1250m west of Pu'unanaha at the approximate elevation of 7800 fasl (0230060E, 2196229N). No archaeological sites were discovered within the area (figure 4).

6. Noise monitor #4 is located within the Astronomy Precinct and was placed between the Subaru telescope and W.M Keck I at the approximate elevation of 13550 fasl (0240706E, 2194085N). There were no newly discovered archaeological sites within the area as Mr. Crowell and Ms. Kerr surveyed the area before the noise monitor was installed (figure 5).

7. Noise monitor #5 is located about 100m south of the Mauna Kea Ice Age Natural Area Reserve (NAR) also adjacent to *Pu'upōhaku* at the approximate elevation of 13,000 fasl (0239084E, 2193631N). There were no newly discovered archaeological sites with the area before the noise monitor was installed (figure 6).

8. Noise monitor #6 is located about 170m northeast of Lake Waiau at the approximate elevation of 13020 fasl (0240628E, 219669N). No newly discovered archaeological sites were found within the area (figure 7).

9. The project location is outside of the boundary of PTA. The Ka'ohe Game Management Area issued a permit to allow the environmental division at PTA, USAG-HI access to the area for the noise control study.

Kehaulani Kerr
Cultural Resource Specialist
Environmental Office, PTA

Godby, William and James Head

2003 Trip Report for the Archaeological Survey of Proposed Helicopter Landing Areas (LZ-5, LZ-5a, and LZ-6) for High Altitude Training from December 8, 2003 to December 12, 2003. On File at PTA.

Pacific Consulting Services, Inc.

2010 Office of Mauna Kea Management: Final Report. *Archaeological Inventory Survey of the Mauna Kea Science Reserve,* v. I.

Pacific Consulting Services, Inc.

2010 Office of Mauna Kea Management: Final Report. *Archaeological Inventory Survey of the Mauna Kea Science Reserve,* v. II.

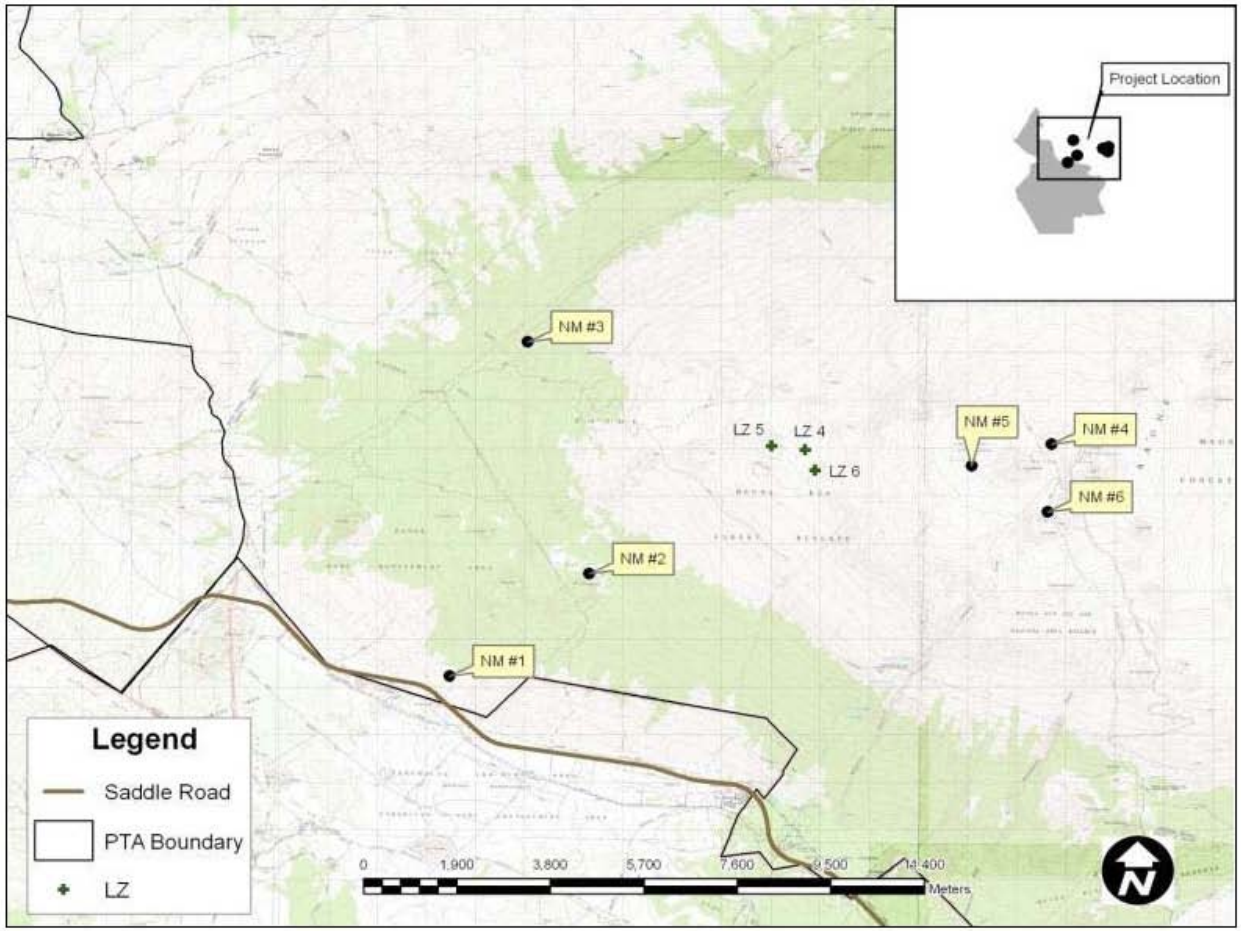


Figure 1. Location of noise monitors

Figure 2. Noise monitor #1

Figure 3. Noise monitor #2

Figure 4. Noise monitor #3

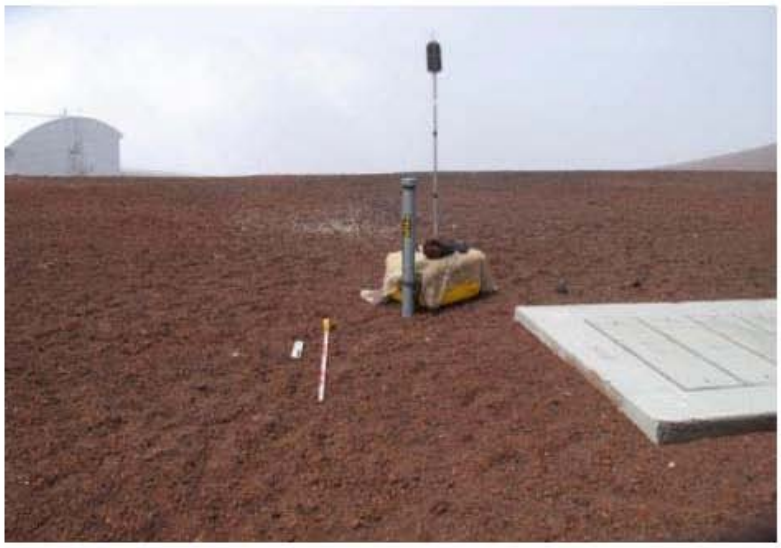


Figure 5. Noise monitor #4

Figure 6. Noise monitor #5

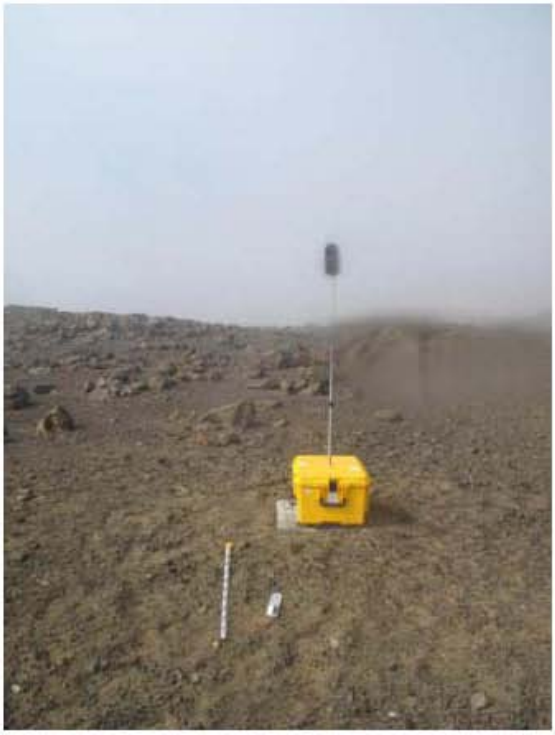


Figure 7. Noise monitor #6

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United States Department of the Interior

NATIONAL PARK SERVICE
Pacific West Region
300 Ala Moana Boulevard, Box 50165
Room 6-226
Honolulu, Hawaii 96850-0053

IN REPLY REFER TO
H4217

November 8, 2010

Department of the Army
U.S. Army Installation Management Command, Pacific Region
Headquarters, United States Army Garrison, Hawaii
Office of the Commander
851 Wright Avenue, Wheeler Army Airfield
Schofield Barracks, Hawaii 96857-5000

Attention: Dr. Julie M.E. Taomia
PTA Archeologist

RE: Section 106 consultation, proposed use of 6 previously disturbed, high elevation helicopter landing zones in the vicinity of the Pohakuloa Training Area (PTA), Island of Hawaii, for training operations.

Dear Dr. Taomia:

We are in receipt of your request for Section 106 consultation regarding the above-referenced undertaking. We understand that these areas are already used by State and private helicopters and will be used in future sporadic training sessions involving landings and takeoffs with no ground altering activities in the helicopter landing zone sites. We acknowledge that PTA cultural resource staff have visited and surveyed the proposed sites and no historic properties were identified in the immediate vicinity.

The National Park Service concurs with the determination that no historic properties will be affected by this project but are concerned with potential noise issues and overflights or flight paths that may affect protected properties and cultural landscapes. We note the proximity of the Mauna Kea landing zones in relation to the Mauna Kea Ice Age Natural Area Reserve and the Mauna Kea National Natural Landmark and the close proximity of the Mauna Loa landing sites to the Kipuka Ainahou Nene Sanctuary.

If you need additional information, please do not hesitate to contact me at (808)541-2693 ext. 723 or by email at Frank_Hays@nps.gov

Sincerely,

Frank Hays
Pacific Area Director

cc: Elaine Jackson-Retondo, NPS, PWR-Oakland
Mark Rudo, NPS, PWR-Oakland

TAKE PRIDE IN AMERICA

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DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND, PACIFIC REGION
HEADQUARTERS, UNITED STATES ARMY GARRISON, HAWAII
851 WRIGHT AVENUE, WHEELER ARMY AIRFIELD
SCHOFIELD BARRACKS, HAWAII 96857-5000

REPLY TO
ATTENTION OF:

OCT 2 0 2010

Office of the Commander

Ms. Laura H. Thielen
State Historic Preservation Officer
Chairperson
Department of Land and Natural Resources Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, HI 96707

Dear Ms. Thielen:

On behalf of the Commander of the US Army Garrison, Hawaii, I am writing to begin consultation under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations (36 CFR Part 800) on a project proposed on Hawaii State land in the vicinity of the Pōhakuloa Training Area (PTA) in Hawai'i County, Island of Hawai'i. There are two proposed project locations, the first within the ahupua'a of Humu'ula, district of North Hilo (TMK: (3) 3-8-001:001), and the second is within the ahupua'a of Ka'ohe, district of Hāmākua (TMK: (3) 4-4-015:001). Please see Enclosure 1 for a list of all consulting parties.

I have determined that this project constitutes an undertaking. The purpose of this undertaking is to utilize six Helicopter Landing Zones (HLZs) in order to conduct high-altitude helicopter training operations. Three of the HLZs are located on Mauna Loa, those in Humu'ula Ahupua'a, and three are on Mauna Kea, in Ka'ohe Ahupua'a. The area of potential effect (APE) consists of three discrete, discontinuous locations on each mountain (six total) that have been bulldozed previously, creating relatively open, level areas (see Enclosure 2). These areas are used by State and private helicopters. In addition, the locations on Mauna Loa are located on the historic 1899 lava flow. Training at the sites will consist of multiple helicopter landings and takeoffs. Of necessity, this helicopter activity will be constrained to the established level areas, as the surrounding terrain, made up of barren lava, is too rugged to accommodate helicopter landing. No ground altering activities will be conducted at the HLZ sites. PTA cultural resource staff have visited and surveyed the proposed HLZ sites and no historic properties were identified (Enclosure 3). Training will take place at these sites sporadically from this time forward.

I have determined that no historic properties will be affected by this project. Pursuant to Section 106 of the National Historic Preservation Act of 1966 as amended and 36 CFR Section 800.2(c), we are seeking your concurrence on this determination. If there is no response to this letter from your office after 35 days of the date of this letter we will assume that you concur with the determinations made herein and the proposed measures for avoidance and the project shall proceed, in accordance with 36 CFR § 800.3(c)(4). Should you require additional information about this project, the point of contact is Dr. Julie M. E. Taomia, PTA Archeologist, at telephone number (808) 969-1966.

Sincerely,

Robert Eastwood

Robert Eastwood
Director of Public Works

Enclosures

Ms. Laura H. Thielen
Chairperson
Department of Land and Natural Resources
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, HI 96707

Mr. Clyde Namuo
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711 Kapiolani Boulevard, Suite 500
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Ms. Lukela Ruddle
Office of Hawaiian Affairs
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Hilo, HI 96720

Ms. Ruby McDonald
Office of Hawaiian Affairs
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Kailua-Kona, HI 96740

Mr. Jonathan Jarvis
Pacific West Region
National Park Service
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Oakland, CA 94607-4807

Mr. Frank Hays
PWRO Honolulu
National Park Service
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Honolulu, HI 96850

Mr. Edward Halealoha Ayau
Hui Malama I Na Kupuna O Hawai'i Nei
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Hilo, HI 96720

Kahu Charles Maxwell
Hui Malama I Na Kupuna O Hawai'i Nei
157 'Ale'a Place
Pukalani, HI 96768

Mr. Kimo Lee
Hawaii Island Burial Council
State Historic Preservation Division
40 Pookela Street Unit C-5
Hilo, HI 96720

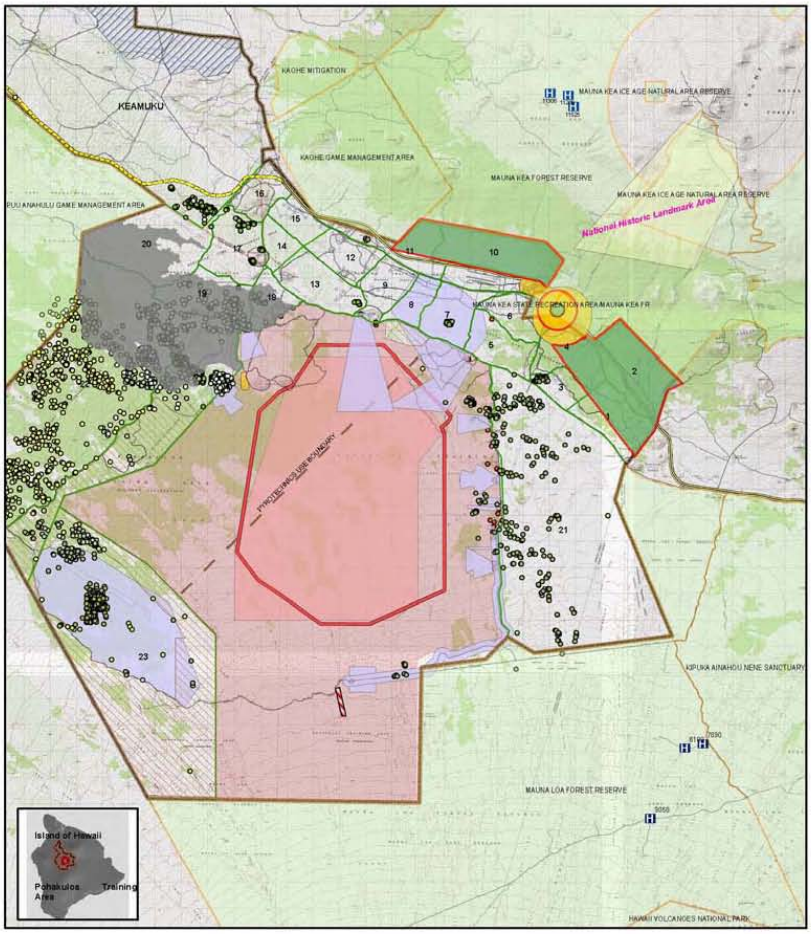
Ms. Ruby McDonald
Hawaii Island Council of Hawaiian Civic Clubs
P.O. Box 85
Kailua-Kona, HI 96745

Ms. Elaine Jackson-Retondo
Pacific West Region
National Park Service
1111 Jackson Street, Suite 700
Oakland, CA 94607-4807

Pohakuloa Cultural Advisory Committee Attendees
Bi-Montly Meetings held at PTA Headquarters

Enclosure 1

25TH COMBAT AVIATION BRIGADE: HIGH-ALTITUDE ARMY AVIATION TRAINING



LEGEND:

- Mauna Kea HAAT LZs
- Mauna Loa HAAT LZs
- National Historic Landmark
- DLNR Reserves

Critical_Habitat

AREA

- PALILA CRITICAL HABITAT
- ENVIRONMENTAL PROTECTED HABITAT

CurrentPlantLocations

NAME

- Asplenium peruvianum
- Haplostachys haplostachya
- Hedyotis coriacea
- Isodendrion hosakae
- Melanthera venosa
- Neraudia ovata
- Portulaca sclerocarpa
- Schiedea hawaiensis
- Silene hawaiensis
- Silene lanceolata
- Solanum incompletum
- Spermolepis hawaiensis
- Stenogyne angustifolia
- Tetramolopium arenarium
- Tetramolopium sp. 1
- Vigna o-wahuensis
- Zanthoxylum hawaiense

- MPRC BUFFER

LABEL

- MAUNA KEA STATE PARK
- STATE PARK BUFFER
- BUFFER
- Roads
- NEW SADDLE ROAD
- SADDLE_RD_POWIANAKO
- DRAFT W7 ALIGN ALTERNATIVES
- RESERVATION BOUNDARY
- Bradshaw Army Airfield
- PTA Buildings Catonement
- TRAINING AREA BOUNDARY
- Existing Ranges
- Training Areas
- TARGET AIRFIELD
- PYROTECHNIC LINE
- IMPACT AREA
- CMBoundry
- Aerial Bombing Box

Hydrology

FTYPE

- AQUEDUCT
- STREAM
- FireBuffer

NOTE:
The 25th Combat Aviation Brigade (25th CAB) has a requirement to train pilots for high-altitude missions according to emergent high-altitude training doctrine and in preparation for deployment in support of Operation Enduring Freedom (Afghanistan). Shown here are the proposed high-altitude landing zones planned for use by 25th CAB 2011 training rotation. These LZs have been previously utilized by DOD.

DATE: 16 SEPTEMBER 2010

CREATED BY: RDH

SCALE: 1:120,000

SCALE BAR:

3,700 1,850 0 3,700 Meters

13,000 6,500 0 13,000 Feet

N W E S

Enclosure 2

View of the location of a proposed landing zone, Mauna Loa.

View of a proposed landing zone, Mauna Loa (same location as previous photo).

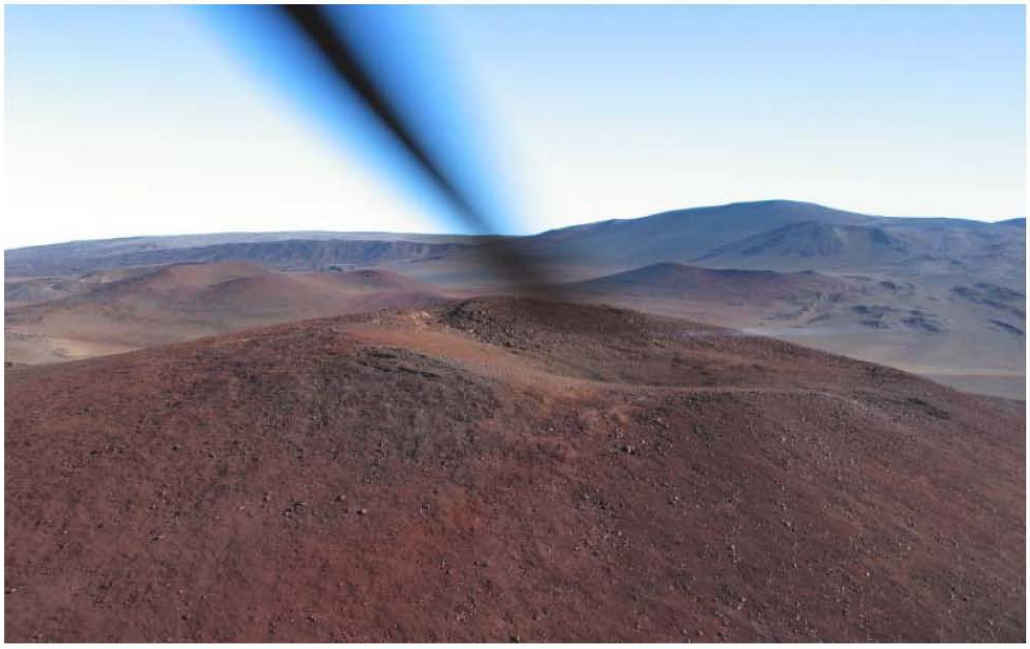
Enclosure 3

View of the location of a proposed landing zone, Mauna Loa.

View of the location of a proposed landing zone, Mauna Loa (same location as previous photo).

View of the location of a proposed landing zone, Mauna Loa.

View of the location of a proposed landing zone, Mauna Loa (same location as previous photo).



View of the location of a proposed landing zone, Mauna Kea.

View of the location of a proposed landing zone, Mauna Kea.

View of the location of a proposed landing zone, Mauna Kea.

View of the location of a proposed landing zone, Mauna Kea (same location as previous photo)

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Appendix E

Aircraft for Use in High-Altitude Mountainous Environment Training

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Appendix E

Aircraft for Use in High-Altitude Mountainous Environment Training

C-1. UH-60L BLACK HAWK

Since October 1989, Sikorsky has been producing the UH-60L Black Hawk helicopter with 24% more power than the UH-60A model. The T700-GE-701C turbine engines enable the UH-60L to take advantage of the new 3,400 shp improved durability main gearbox (Global Security 2010a).

The UH-60L was further modified with Seahawk® flight control components and an increase in tail rotor pitch. These modifications allow the aircraft to take full advantage of available engine power while extending the flight control component fatigue lives in excess of 5,000 hours.

As an example of the benefits of this upgrade, a modified UH-60L Black Hawk is capable of airlifting a 9,000-lb (4,082-kg) external payload, 60 nautical miles under hot day conditions, an increase of 3,000 lb (1,360 kg) over the UH-60A model.

In response to the growing weights of external loads such as weaponized M1036 High Mobility Multipurpose Wheeled Vehicles (HMMWV), the U.S. Army increased the external hook capacity to 9,000 lb (4,082 kg) for a gross weight of 23,500 lb (10,433 kg). This improvement, for example, allows organic UH-60L aviation resources to more closely match the lift requirements within the Light Infantry Divisions.

The world's most advanced twin-turbine military helicopter, the UH-60L is powered by twin General Electric T700-GE-701C turboshafts rated 1,890 shp each, plus the 3,400 shp Improved Durability Gearbox and heavy-duty flight controls developed for the naval S-70B Seahawk. It is cleared to 22,000 lb (9,979 kg) gross weight and can carry 9,000 lb (4,082 kg) external loads. New wide-chord composite main rotor blades and further engine upgrades are available for future performance requirements.

An External Stores Support System (ESSS), consisting of removable four-station pylons, multiplies Black Hawk roles. With the ESSS, the UH-60L can carry additional fuel tanks for extended range in self-deployment up to 1,150 nautical miles. For anti-armor missions, it can carry 16 Hellfire missiles on the pylons or a variety of other ordnance, including guns and rockets.

C-2. UH-60A BLACK HAWK

The UH-60A Black Hawk is the primary division-level transport helicopter, providing dramatic improvements in troop capacity and cargo-lift capability compared to the UH-1 Series “Huey” it replaces. The UH-60A, with a crew of three, can lift an entire 11-man fully-equipped infantry squad in most weather conditions. It can be configured to carry four litters, by removing eight troop seats, in the medical evacuation role (Global Security 2010).

Both the pilot and co-pilot are provided with armor-protective seats. Protective armor on the Black Hawk can withstand hits from 23-mm shells. The Black Hawk has a cargo hook for external lift missions. The Black Hawk has provisions for door mounting of two M60D 7.62-mm machine guns on the M144 armament subsystem and can disperse chaff and infrared jamming flares using the M130 general-purpose dispenser. The Black Hawk has a composite titanium and fiberglass four-bladed main rotor, is powered by two General Electric T700-GE-700 1622 shp turboshaft engines, and has a speed of 163 mph (142 knots).

The UH-60, first flown in October 1974, was developed as result of the Utility Tactical Transport Aircraft System (UTTAS) program. The UTTAS was designed for troop transport, command and control, medical evacuation, and reconnaissance, to replace the UH-1 Series “Huey” in the combat assault role. In August 1972, the U.S. Army selected the Sikorsky (Model S-70) YUH-60A and the Boeing Vertol (Model 237) YUH-61A (1974) as competitors in the UTTAS program. The Boeing Vertol YUH-61A had a four-bladed composite rotor, was powered by the same General Electric T700 engine as the Sikorsky YUH-60A, and could carry 11 troops. In December 1976, Sikorsky won the competition to produce the UH-60A, subsequently named the Black Hawk.

Elements of the U.S. Army Aviation UH-60A/L Black Hawk helicopter fleet began reaching their service life goal of 25 years in 2002. In order for the fleet to remain operationally effective through the time period 2025–2030, the aircraft will need to go through an inspection, refurbishment, and modernization process that will validate the structural integrity of the airframe, incorporate improvements in subsystems so as to reduce maintenance requirements, and modernize the mission equipment and avionics to the levels compatible with Force XXI and Army After Next (AAN) demands.

A Service Life Extension Program (SLEP) for the UH-60 began in Fiscal Year 1999. The UH-60 modernization program identifies material requirements to effectively address known operational deficiencies to ensure the Black Hawk is equipped and capable of meeting battlefield requirements through the 2025–2030 timeframe. Primary modernization areas for consideration are increased lift, advanced avionics (digital communications and navigation suites), enhanced aircraft survivability equipment (ASE), increased reliability and maintainability (R&M), airframe SLEP, and reduced operations and support (O&S) costs. Suspense date for the approved Operational Requirements Document (ORD) was December 1998.

C-3. CH-47D/F CHINOOK OVERVIEW

The Chinook is a multi-mission, heavy-lift transport helicopter. Its primary mission is to move troops, artillery, ammunition, fuel, water, barrier materials, supplies, and equipment on the battlefield. Its secondary missions include medical evacuation, disaster relief, search and rescue, aircraft recovery, fire fighting, parachute drops, heavy construction, and civil development. Chinook helicopters were introduced in 1962 as the CH-47 Chinook, and models A, B and C were deployed in Vietnam.

As the product of a modernization program, which included refurbishing existing CH-47s, the first CH-47Ds were delivered in 1982 and were produced until 1994. A central element in the Gulf War, they continue to be the standard for the U.S. Army in the global campaign against terrorism. Since its introduction, 1,179 Chinooks have been built (Boeing 2010).

C-3.1 CH-47F Chinook

To extend the service life of the CH-47 beyond 2030, Boeing developed the CH-47F in the mid-1990s and began production in 2003. Boeing is conducting major cost reduction initiatives, which improve manufacturing processes and affordability (Boeing 2010).

The program features improvement aimed at reducing operating and support costs; improving reliability, availability, and maintainability (RAM); and providing digital battlefield compatibility in communications and navigation. The program included modernization of 394 existing CH-47Ds and production of 17 new helicopters. The CH-47F Chinooks possess the following capabilities and characteristics:

- Improved airframe structure to reduce vibration effects
- Structural enhancements in the cockpit, cabin, aft section, pylon, and ramp – flexible paint system with corrosion preventive compounds
- Integrated cockpit control system – Common Aviation Architecture System
- Improved electrical, avionics, and communication systems
- Improved Avionics with Digital Advanced Flight Control System – situational awareness and improved digital map display
- More powerful engines with digital fuel controls – two turbine engine hubs, each with a Textron Lycoming T55-L714 engine and each with 4,900 shp
- A maximum payload capacity of 21,500 lb (9,752 kg) (based on U.S. Army requirements for the CH-47F)

- An operating range up to 329 nautical miles
- Modularized hydraulics and triple cargo hooks
- Composite, manual-folding, tandem-rotor blades with three blades per hub.

C-3.2 CH-47D and Cargo Helicopter Airframe Procurement Support (CHAPS)

Currently, the U.S. Army and international countries operate more than 600 CH-47D Chinooks. This model will be operated and supported through 2018 by the U.S. Army and Boeing until the CH-47F is in full production. The CHAPS program provides for the sale of flight-ready CH-47D Chinooks under "Exchange and Sales" regulations. Under this program, select D-Model Chinooks from the U.S. Army fleet are available to military users and service organizations worldwide, providing them affordable aircraft fully capable and easily upgradable to include any future system provided in the CH-47D. CHAPS provides countries affordable alternatives to more advanced aircraft and enables users to support military operations, medical and disaster relief, search and rescue, fire fighting, and civil support with reliable, cost-efficient helicopters (Boeing 2010). Chinook CH-47Ds possess the following capabilities and characteristics:

- Two turbine engine hubs, each with a Textron Lycoming T55-L714 engine
- Heavy payload capable
- Fully supportable and upgradable.

C-4. KIOWA OVERVIEW

Developed from the civil Bell Model 206A Jet Ranger helicopter, the U.S. Army's OH-58 Kiowa served extensively in Vietnam in the light observation and scout roles. The OH-58 Kiowa was built in significant numbers for military service and remains in widespread use within the U.S. Army in upgraded OH-58C form. The Kiowa also serves as a trainer with the U.S. Navy as the TH-57 Sea Ranger and with the U.S. Army as the TH-67A Creek (Military Today 2011).

C-5. OH-58C KIOWA RECONNAISSANCE HELICOPTER

The OH-58C is an upgrade from the OH-58A model helicopter. The OH-58C is a single-engine, double-bladed helicopter much like the OH-58D. The Bell OH-58 is a versatile all-metal, light-observation helicopter used for observation, scout, and command and control in the U.S. and overseas military forces. It appears similar to the civilian series of the Bell 206 Jet Ranger but is fitted with a 420 SHP T63-A-720 engine and is equipped with the Black Hole infrared (IR) signature-suppression system and low-glare flat plate windshields, and it is night-vision-goggle compatible. It has a single two-bladed, semi-rigid, teetering main rotor and an anti-torque tail rotor (Flight Research 2011).

The cockpit provides side-by-side seating for a crew of two, seats for two passengers in the rear compartment, and has provisions for an XM-27E1, 7.62-mm, mini-gun armament system. In addition, the FRI OH-58C has an advanced instrumentation system specifically developed for recording performance and flying qualities data (Flight Research 2011).

C-6. OH-58D KIOWA WARRIOR RECONNAISSANCE/ ATTACK HELICOPTER

The Armed OH-58D Kiowa Warrior, in service with the U.S. Army, is supplied by Bell Helicopter Textron of Fort Worth, Texas. Around 375 Kiowas are in service, and the single-engine, four-bladed armed reconnaissance helicopter has been deployed in support of U.S. armed forces around the world, including Haiti, Somalia, and the Gulf of Arabia (Desert Storm and Desert Shield). In 2002, Kiowas were deployed as part of NATO's SFOR forces in Bosnia, and, in 2003, 120 Kiowas were deployed in support of Operation Iraqi Freedom (Army-Technology 2010).

Two Kiowas can be transported in a C-130 aircraft. For air transportation, the vertical tail fin pivots, the main rotor blades and the horizontal stabilizer are folded, and the mast mounted sight, the IFF antenna, and the lower wire cutter are removed. The landing gear can kneel to decrease the height.

C-4.1 Cockpit

The Kiowa was the first U.S. Army helicopter to have an all-glass cockpit. The cockpit is supplied by Sperry Flight Systems and is equipped with a multiple target tracking/moving target indicator, an ANVIS (Aviation Night Vision System) Display Symbology System, and a helmet-mounted display. The primary multi-function displays provide situation information, communications control, and the mast-mounted sight video. A video recorder stores television and thermal imagery from the mission and allows playback in the cockpit.

C-4.2 Weapons

The OH-58D is equipped with two universal quick change weapons pylons. Each pylon can be armed with two Hellfire missiles, seven Hydra 70 rockets, two air-to-air Stinger missiles, or one .50-caliber fixed-forward machine gun.

Mission processors control the suite of mission subsystems via a Military Standard 1553B bus. An onboard computer provides laser ranging and target location within 10 m.

C-4.3 Countermeasures

The countermeasures suite includes an AN/ALQ-144 infrared jammer, radar warning receivers against pulsed and continuous wave radars, and a laser warning detector.

C-4.4 Fire Control and Observation

The distinctive Mast Mounted Sight (MMS) from Boeing, situated above the rotor blades, enables the Kiowa Warrior to operate by day and night and to engage the enemy at the maximum range of the weapon systems and with minimum exposure of the helicopter. The mast-mounted sight contains a suite of sensors that includes a high-resolution television camera for long-range target detection; a thermal imaging sensor for navigation, target acquisition, and designation; a laser rangefinder/designator for target location and guidance of the Hellfire missiles and designation for Copperhead artillery rounds; and a boresight assembly that provides in-flight sensor alignment. The laser rangefinder/designator is also employed for handoff to an AH-1 Cobra helicopter for TOW missile engagements.

DRS Technologies was responsible for the contract for the sensor suite and, in February 2005, was awarded a contract to upgrade the thermal imaging system on the MMS. The Thermal Imaging Systems Upgrade (TISU) provides enhanced target detection and range.

C-4.5 Navigation and Communications

The U.S. Army OH-58D is equipped with an attitude heading reference system (AHRS) from Litton and an integrated global positioning system and inertial navigation system, GPS/INS. A data-loading module allows the pre-mission storing of navigation waypoint data and radio frequencies.

The mission equipment includes an Improved Data Modem for Digital Battlefield Communications (IDMDBC). The communications system is based on the Have-Quick UHF and SINCGARS FM anti-jam radio.

C-4.6 Engine

The OH-58D Helicopter is equipped with a Model 250 485-kW turbine engine from Rolls-Royce. The transmission has a transient power level of 475 kW. The engine and transmission system have been upgraded to provide high-performance levels in high temperature and extreme environments.

C-7. REFERENCES

Army-Technology, 2010, *OH-58D Kiowa Warrior Reconnaissance / Attack Helicopter, USA*, http://www.army-technology.com/projects/kiowa/, Web page visited November 2, 2010.

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Appendix F

Memorandums for the Record

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Peshut 2011b—ESA-7(c) Determination of No Effect for High-Altitude Mountainous Environment Training (HAMET) at Mauna Kea and Mauna Loa, Hawaii Island F-13

Peshut and Doratt 2011a—Hawaiian Hoary Bat Surveys for HAMET Environmental Assessment F-21

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Peshut and Doratt 2011c—Wekiu Bug and Invasive Ant Surveys for HAMET Environmental Assessment F-47

Peshut and Evans 2011—Botanical Surveys for HAMET Environmental Assessment F-65

Peshut and Schnell 2011a—Hawaiian Avifauna Surveys for HAMET Environmental Assessment F-77

Peshut and Schnell 2011b—Hawaiian Petrel Surveys for HAMET Environmental Assessment F-125

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DEPARTMENT OF THE ARMY
HEADQUARTERS,
UNITED STATES ARMY GARRISON
PŌHAKULOA
PO BOX 4607
HILO, HAWAII 96720-0607

IMPC-HI-PS 18 April 2011

MEMORANDUM FOR RECORD

SUBJECT: Aerial surveys for fugitive dust and vegetation impacts at Mauna Kea LZs to support HAMET Environmental Assessment

Aerial surveys were conducted at Mauna Kea landing zones LZ 4, LZ 5 and LZ 6 on 18 April 2011, by Peter Peshut, PhD, to assess the generation of fugitive dust and potential impacts to vegetation as a result of HAMET operations.

Mauna Kea LZs are on State of Hawaii land in the Mauna Kea Forest Reserve. Landing zone geographic coordinates are given in Table 1. Landing zones are shown graphically in Figure 1. Each Mauna Kea LZ is an undisturbed natural lava area approximately 100 x 100 ft.

Table 1. Landing Zone Geographic Coordinates

Landing Zone	Latitude (N)	Longitude (W)	Elevation (ft)
Mauna Kea LZ4	19° 49’ 26.24”	155° 31’ 23.51”	11,208
Mauna Kea LZ5	19° 49’ 28.31”	155° 31’ 47.00”	11,324
Mauna Kea LZ6	19° 49’ 12.11”	155° 31’ 16.31”	11,539

In the field, a UH-60 Blackhawk helicopter from Bradshaw Army Airfield transited to and from the Mauna Kea LZs along established flight paths (see HAMET EA, April 2011). At each LZ the aircraft hovered for 1 minute at ~10 ft above the LZ geographic coordinate. After hover, the aircraft departed the LZ and observations were made along a circular flight path ~300 ft from the LZ center, at elevation ~100 ft above ground level.

The effect of rotorwash (helicopter generated winds) is a function of distance from the aircraft. Vertically, rotorwash effect height = 1.5x rotor diameter (P. Mansoor, CW4, personal communication, 2011). For the UH-60 Blackhawk, rotorwash is first felt at the

Appendix F

Memorandums for the Record

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Contents

Aerial Surveys for Fugitive Dust and Vegetation Impacts at Mauna Kea LZs to Support HAMET Environmental Assessment (Peshut 2011a) F-5

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Hawaiian Avifauna Surveys for HAMET Environmental Assessment (Peshut and Schnell 2011a) F-77

Hawaiian Petrel Surveys for HAMET Environmental Assessment (Peshut and Schnell 2011a) F-125

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ground surface when the aircraft is ~80 feet overhead. Horizontally, at hover, rotorwash from the UH-60 Blackhawk diminishes to ambient wind conditions at ~140 ft from the aircraft. The horizontal effect of UH-60 rotorwash was measured under controlled conditions at Bradshaw Army Airfield as an aircraft hovered ~10 ft above the runway surface (P. Peshut, personal observations, 31 March 2011).

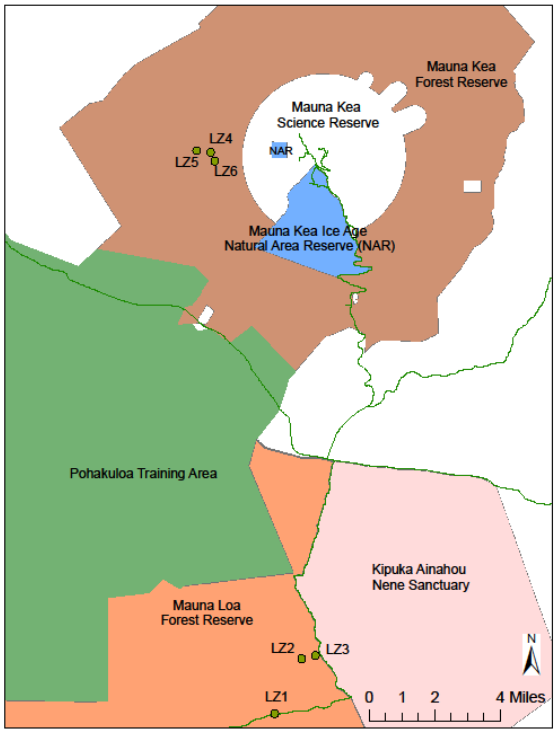

Figure 1. Mauna Kea and Mauna Loa Landing Zones

For all Mauna Kea LZs, there were no impacts to vegetation during helicopter approach, hover, or departure from the LZs. Mauna Kea LZ 5 and LZ 6 are devoid of vegetation within ~150 ft of the LZ center. For Mauna Kea LZ 4, vegetation within 150 ft of the LZ center is limited to sparse clumps of distressed grasses of ~4 inches diameter, widely spaced at ~50-100 ft. See Peshut and Evans MFR 30 March 2011 for a description of vegetation at Mauna Kea LZs.

No fugitive dust was observed at any Mauna Kea LZ during aircraft approach, hover, or departure from the LZs (Figure 2 – Figure 10). Substrate at the Mauna Kea LZs consists of lava pieces ½-6 inches, with little or no entrained fine-grained material. See Peshut and Evans MFR 30 March 2011 for a description of substrate at Mauna Kea LZs.

Figure 2. Aerial Observation Mauna Kea LZ 4 - Approach

Figure 3. Aerial Observation Mauna Kea LZ 4 - Hover

Figure 4. Aerial Observation Mauna Kea LZ 4 - Departure

Figure 5. Aerial Observation Mauna Kea LZ 5 - Approach

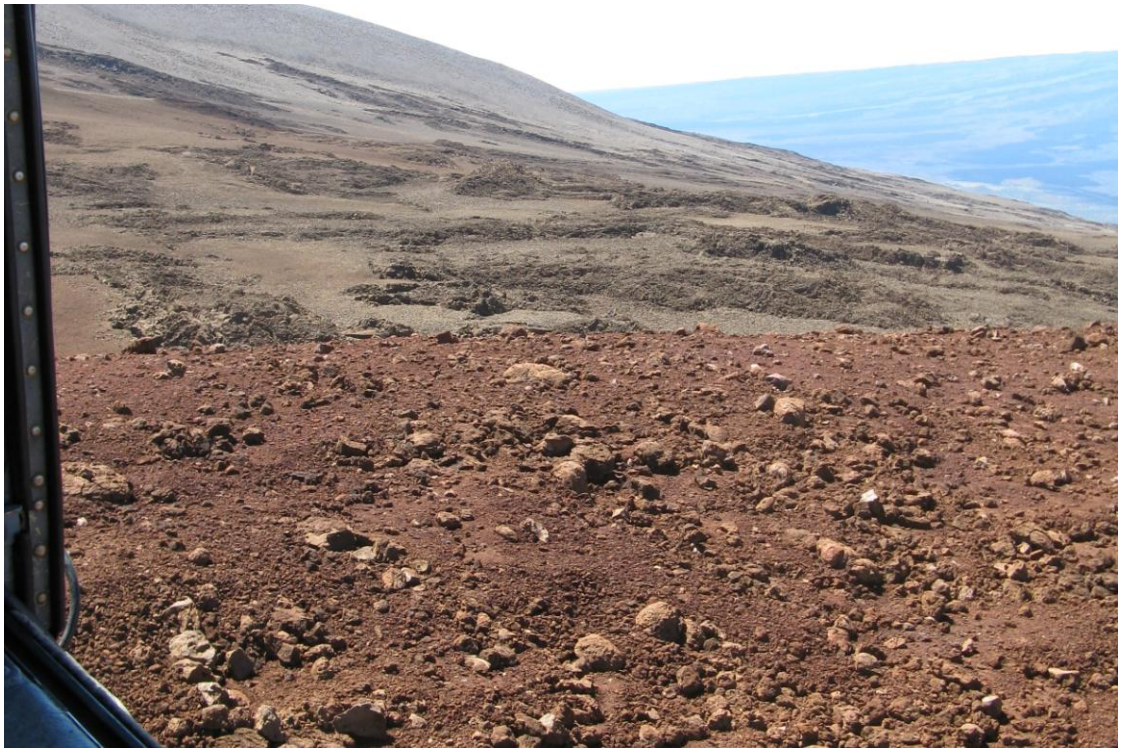

Figure 6. Aerial Observation Mauna Kea LZ 5 - Hover

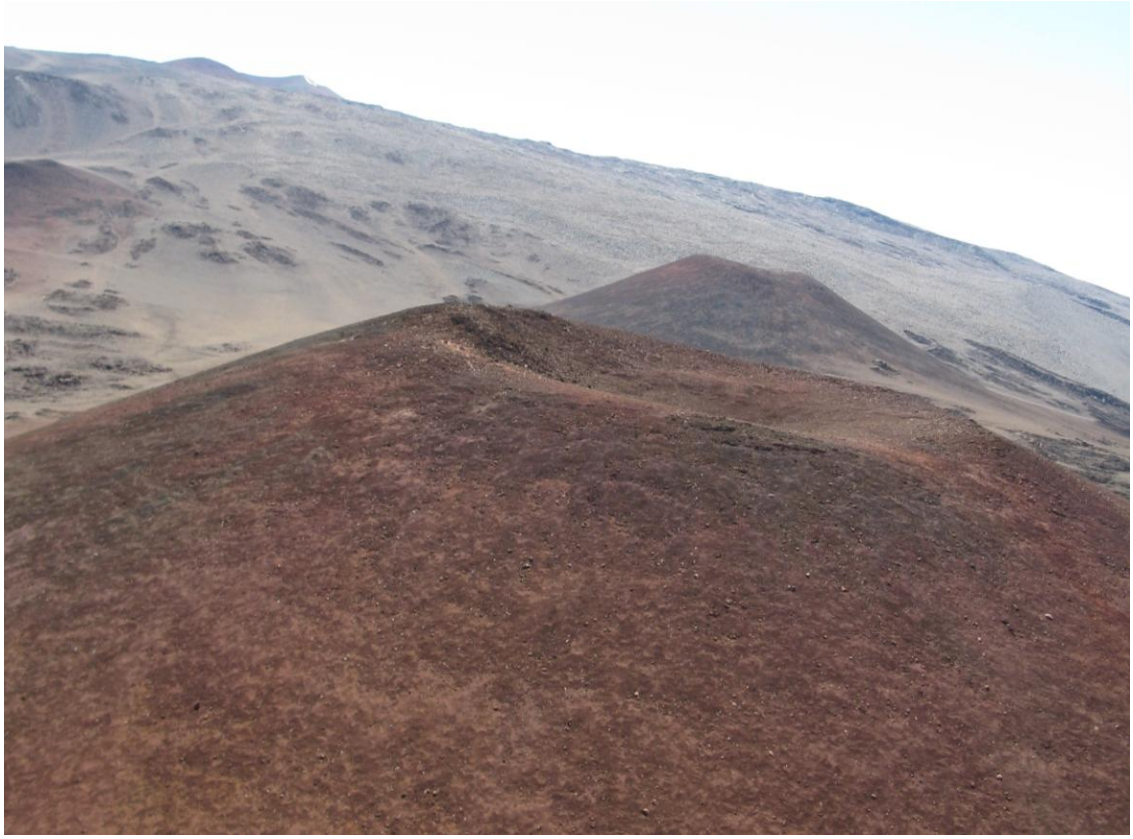

Figure 7. Aerial Observation Mauna Kea LZ 5 - Departure

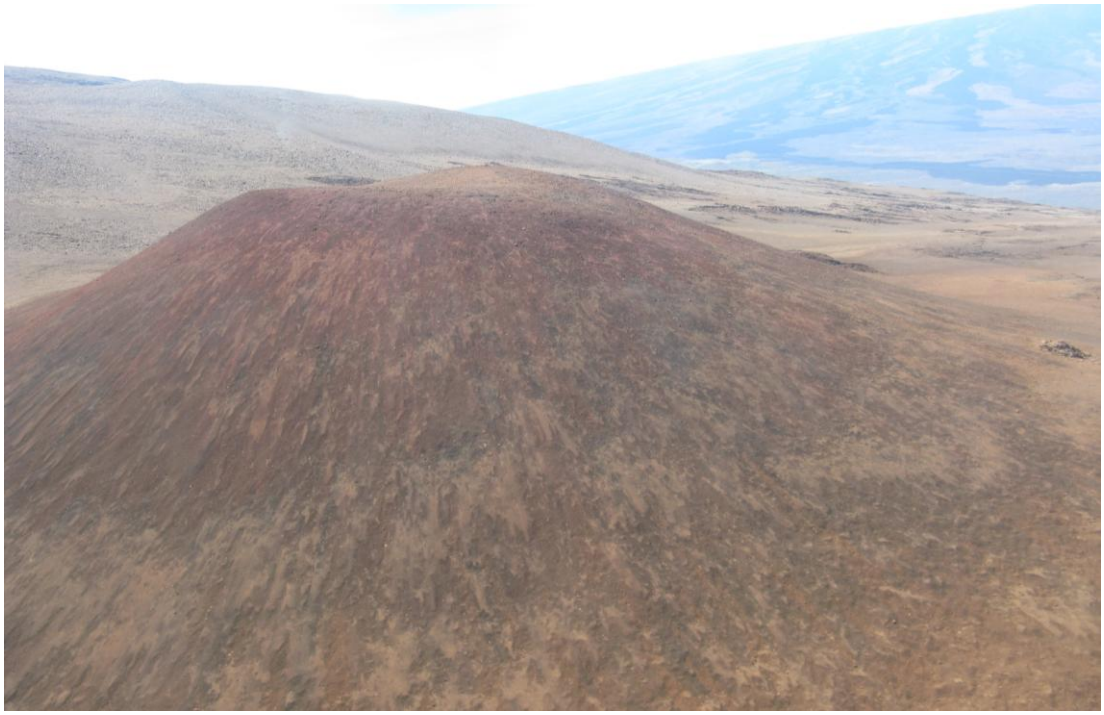

Figure 8. Aerial Observation Mauna Kea LZ 6 - Approach

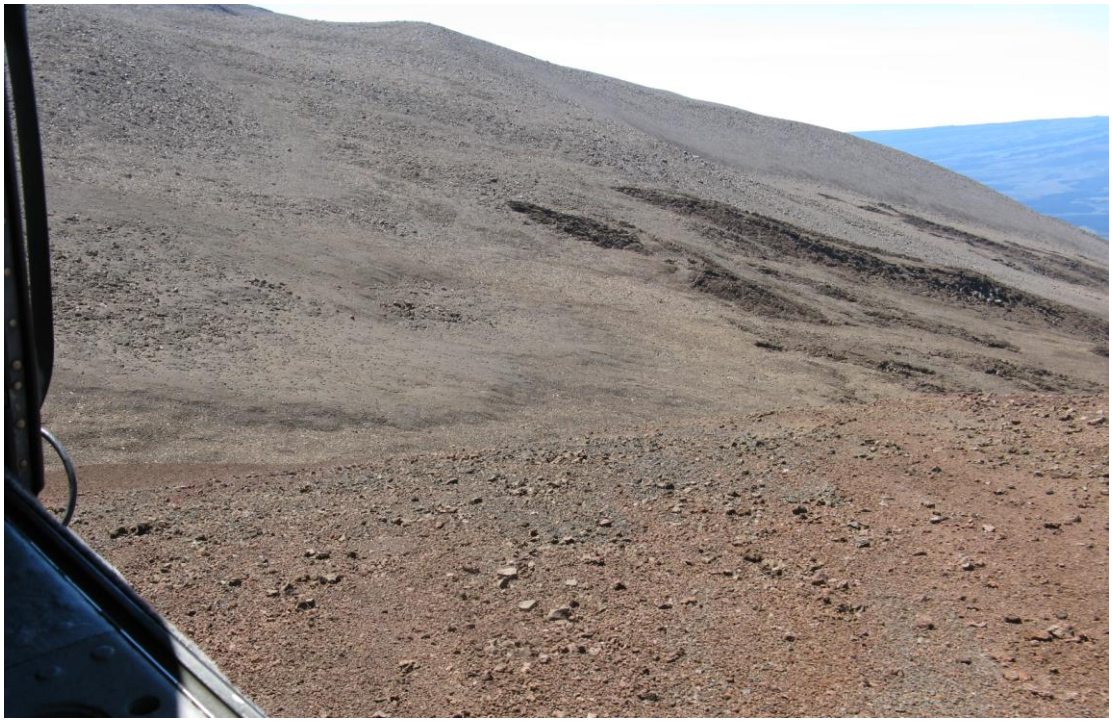

Figure 9. Aerial Observation Mauna Kea LZ 6 - Hover

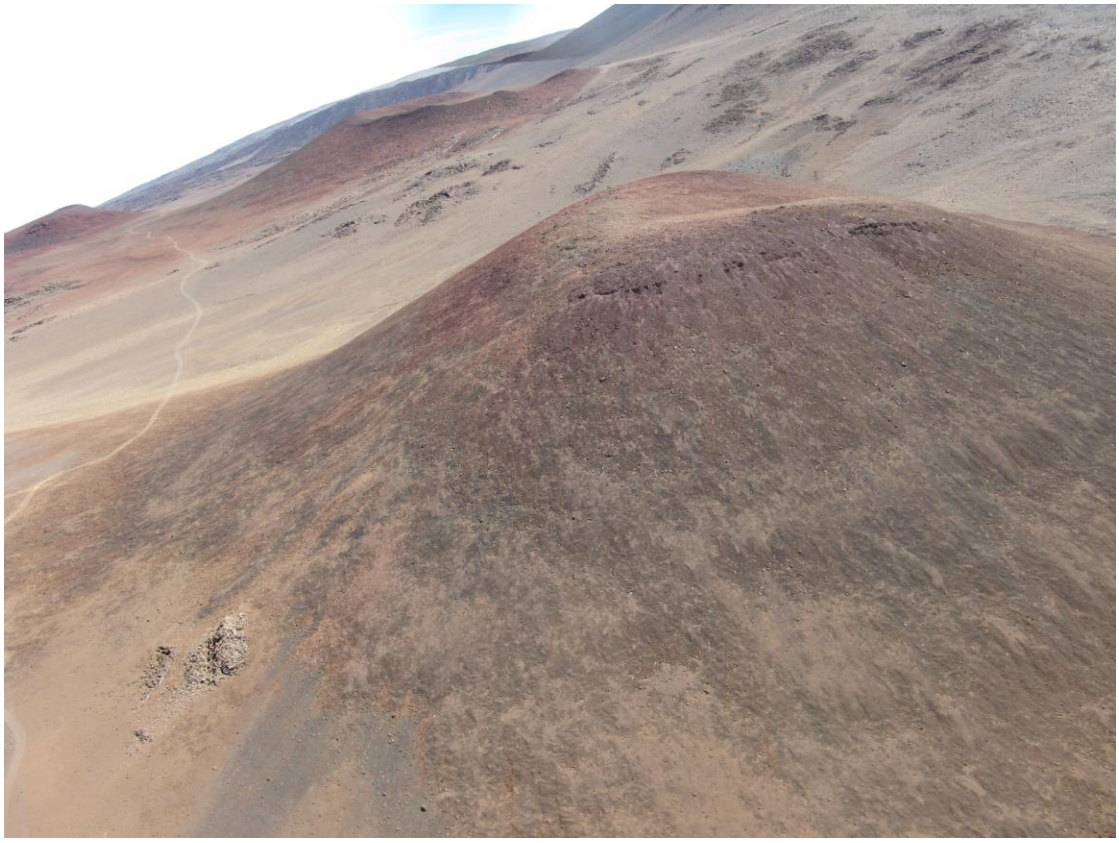

Figure 10. Aerial Observation Mauna Kea LZ 6 - Departure

Point of contact to further discuss aerial surveys for fugitive dust and vegetation impacts at Mauna Kea LZs is Peter Peshut, 808-969-1966, peter.peshut@us.army.mil.

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IMPC-HI-PS

MEMORANDUM FOR RECORD 20 June 2011

SUBJECT: ESA-7(c) Determination of No Effect for High-Altitude Mountainous Environment Training (HAMET) at Mauna Kea and Mauna Loa, Hawaii Island

The US Army developed the HAMET program to prepare pilots for successful combat operations as part of Operation Enduring Freedom in Afghanistan (US Army, 2009). HAMET involves three phases: 1) academic and simulator training; 2) basic qualification, and; 3) tactical operations exercises. HAMET is essential pilot training because high altitudes and mountainous terrain produce aerodynamic and atmospheric effects on rotary-wing aircraft that differ from effects at lower altitudes and over moderate terrain. Conditions at high altitudes may include high winds, extreme turbulence, low air density, and unpredictable air stability. These conditions can significantly affect engine performance and handling characteristics of rotary-wing aircraft (US Army, 2011). Army helicopter pilots need to understand and experience the challenges of flight planning and aircraft operations at high altitudes in order to be competent for missions in mountainous environments such as Afghanistan.

In preparation for deployment to theatre of operation and to satisfy compulsory aviation training requirements, the 25th Combat Aviation Brigade stationed at Wheeler Army Airfield, Hawaii, proposes to provide HAMET for helicopter aviators at landing zones (LZs) on Mauna Kea and Mauna Loa, Hawaii. The proposed action sustains Department of Army and Department of Defense training requirements and meets HAMET Phase 3 objectives. Aviators and crews will train on aircraft internal to the 25th Combat Aviation Brigade, Hawaii.

The US Army has developed Action Alternatives and a No Action Alternative to evaluate the proposed HAMET Action, as described in the HAMET Environmental Assessment (US Army, 2011). The No Action Alternative serves as a benchmark against which the proposed alternatives can be evaluated. Since the proposed action is to conduct HAMET Phase 3 tactical operations exercises, the purpose of the Action will not be achieved if the No Action Alternative is selected (US Army, 2011).

Action Alternatives 1-3 involve the execution of HAMET flights between Bradshaw Army Airfield at Pohakuloa Training Area and six landing zones selected on Mauna Kea

and Mauna Loa. These six LZs were chosen based on training-appropriate characteristics and safety considerations. The selected LZs meet the criteria for HAMET objectives and are suitable for use without further modification.

Biological resources within the HAMET project area include vegetation and wildlife. Potential impacts to vegetation (including palila critical habitat) include habitat disturbance, including habitat loss from wildland fire, temporary localized impacts from dust and wind generated from helicopter rotorwash, and the spread of invasive plant species. Potential impacts to wildlife are noise disturbance, habitat disturbance, including habitat loss from wildland fire, the spread of invasive ant species, and direct impact with aircraft.

Biological surveys were conducted for each LZ to determine the reasonable likelihood that potential impacts will occur to biological resources as a result of HAMET operations. A Memorandum For Record that describes findings for each survey was prepared for the file record. Based on findings, there is no reasonable likelihood that HAMET operations will have a sustained detrimental effect on biological resources of the Mauna Kea and Mauna Loa LZs. Surveys results and conclusions are summarized briefly below.

Botanical surveys were conducted 23 February 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3, and 24 February 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6, to determine the presence of federally-listed plant species and to assess overall vegetation in the general vicinities of the LZs (see Peshut and Evans Memorandum For Record 30 March 2011). Survey areas for each LZ included a square ~650 ft (200 m) on each side centered on the geographic coordinate of respective LZs.

No federally-listed or candidate plant species were located at any of the LZs or within any LZ survey area. In general, vegetation at the LZs is extremely sparse or absent, and is limited to a few common native or introduced species. HAMET operations will produce little or no dust at LZs, and the highly localized and short duration winds generated from aircraft rotorwash are not likely to permanently impact the sparse and stressed vegetation that occur at LZs (see Peshut Memorandum For Record 18 April 2011).

There are no effects to vegetation from human foot traffic at any LZ because there is no disembarkation of personnel during HAMET operations.

The impact to biological resources from wildland fire generated from a helicopter crash at an LZ is negligible because of the extremely sparse vegetation around the LZs, which provides a low density fuel load and limits the spread of fire.

The impact to biological resources from wildland fire generated from a helicopter crash along a flight path to an LZ (including over palila critical habitat) during HAMET

operations, is considered negligible. For the military, hundreds of helicopter flights and thousands of hours of flight time are logged at Pohakuloa each year. Moreover, commercial helicopters plying the tourist trade on Hawaii Island transit palila critical habitat regularly throughout the year, with no restrictions on flight paths or elevation. At a larger scale, thousands of commercial flights for public and private travel cross population centers and biologically sensitive areas daily, across the globe. Aircraft crashes are phenomenally rare given the numbers of aircraft and flight hours logged worldwide. It is reasonable to suggest that the potential for a helicopter crash from HAMET operations is extremely low. The likelihood of a helicopter crash during HAMET operations was not considered tenable.

Surveys to assess potential available treeland roosting habitat and potential foraging habitat for the federally-listed Hawaiian Hoary Bat were conducted 02 March 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3, and 03 March 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6, to determine the potential for bat presence in the general vicinities of the LZs (see Peshut and Doratt Memorandum For Record 04 April 2011). Survey areas for each LZ included a square ~650 ft (200 m) on each side centered on the geographic coordinate of respective LZs, similar to the survey area for the botanical surveys. Botanical survey data was used to augment the assessment of potential bat habitat.

As described for the botanical surveys, in general, vegetation at the LZs is extremely sparse or absent, and is limited to common native or introduced species. The Mauna Kea LZs are essentially devoid of vegetation and provide no habitat that could reasonably be considered as potential roosting or foraging habitat for the Hawaiian Hoary Bat. Vegetation at the Mauna Loa LZs is also extremely sparse, and there is no vegetation greater than 3 ft (1 m) in height within any of the Mauna Loa LZ survey areas. Overall, the LZs do not provide potential roosting or foraging habitat for the Hawaiian Hoary Bat.

Bat presence within the LZ areas is expected to be limited to rare and infrequent transiting bats, and bat density in the LZ areas is expected to be extremely low. Airstrike of bats is therefore considered to be unlikely. The potential for a helicopter collision with the Hawaiian Hoary Bat is unlikely because the bats are solitary, are only active from sunset to sunrise, only roost in trees in forested areas, and are not expected to depend upon the habitat around the LZs for resources. If transiting bats are present during HAMET operations, bats are expected to vacate the immediate vicinities of the aircraft and the LZ.

Preliminary and final surveys to assess the presence of the candidate species *Nysius wekiuicola* (Wekiu bug) and the presence of invasive ant species were conducted 02 March 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6, on 03 March 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3, on 31 May 2011 at Mauna Loa LZ 1, LZ 2 and LZ3, on 06 June 2011 at Mauna Kea LZ 4, LZ 5and LZ 6, and on 08 June 2011 at Mauna Kea LZ 5 and LZ 6. See

Peshut and Doratt Memorandum For Record 04 April 2011, and Peshut and Doratt Memorandum For Record 20 June 2011. Surveys for Wekiu and ants covered a period of several months to account for the seasonal behavior of these species. It was determined that Mauna Kea LZ 4 does not present viable habitat for the Wekiu bug, and this LZ was not subject to a final survey to confirm the presence or absence of the bug. The Wekiu bug is not known to inhabit Mauna Loa LZs. Mauna Loa LZs were surveyed for invasive ant species only. Survey areas for each LZ included a circle of ~650 ft (200 m) radius centered on the geographic coordinate of respective Mauna Kea LZs. No Wekiu bug or ants were found at any LZ during any survey.

Preliminary and final surveys to determine bird presence and habitat use in the general vicinities of the LZs (including listed and candidate petrel species) were conducted 02 March 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3, on 03 March 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6, and on 25-26 May 2011 and 06-07 June 2011 at all Mauna Kea and Mauna Loa LZs. Surveys for petrels covered a period of several months to account for the seasonal behavior of these species. See Peshut and Schnell Memorandum For Record 04 April 2011, and Peshut and Schnell Memorandum For Record 10 June 2011. Survey areas for each LZ included a circle of 2000 ft (610 m) radius centered on the geographic coordinate of respective LZs, corresponding to the 80 dB noise contour for helicopter operations at LZs.

Several bird species protected under the Migratory Bird Treaty Act were identified at the LZs, as were game bird species not protected under federal law. Overall densities of these birds within the survey areas were extremely low. These bird species are expected to vacate the immediate vicinities of the aircraft and LZs if present during HAMET operations.

The Hawaiian Goose (Nene) is known to frequent the regions within several miles of the Mauna Loa LZs, but geese densities are expected to be extremely low in the areas of LZs, and if present geese are expected to vacate the immediate vicinities of aircraft and LZs during HAMET operations. An air collision with the Nene is unlikely. The island-wide population of nene is ~500, of which only ~200 are known to transit Pohakuloa between population centers in Hakalau (east) and Puuanahulu (west). Nene do not spend a significant portion of their time in the air, and do not typically fly at night. Nene spend most of their time on the ground, loafing, feeding, sleeping, or tending nests. Nene are not expected to be present in the vicinities of the Mauna Kea LZs.

There was no evidence of habitat use or colony activity by the listed and candidate species of Dark-rumped Petrel and Band-rumped Petrel. Although the region of the Mauna Loa LZs is thought to be part of the flyway used by petrels transiting the saddle region to colonies in Hawaii Volcanoes National Park, petrel presence in the flyway is

indeterminable. Like other birds, petrels are expected to vacate the immediate vicinities of the aircraft and LZs if present during HAMET operations.

Collision with palila is highly unlikely because aircraft will maintain an altitude of at least 2000 feet above ground level when flying over critical habitat.

The spread of invasive species within the project area will be reduced by inspecting and cleaning the exterior of the HAMET aircraft at the Bradshaw Army Air Field prior to training flights.

The impact to biological resources due to noise is considered negligible. HAMET operations will produce ~10 minutes of noise disturbance per LZ per landing event, with the highest noise levels ~100 dB within ~100 ft of the geographic center of the LZ.

The impact to biological resources due to wind generated by helicopter rotorwash is considered negligible. HAMET operations will produce <2 minutes of wind disturbance per LZ per landing event, with the highest wind velocities within ~50 ft of the geographic center of the LZ, and falling off to ambient wind conditions ~140 ft from the aircraft, which is within the LZ perimeter.

The US Army will implement the following mitigation measures for HAMET operations:

- Helicopters will maintain an altitude of at least 2000 feet above ground level when flying over palila critical habitat;
- Helicopters will be inspected for invasive arthropod and plant species prior to each mission, and cleaning protocols will be followed if invasive species are identified;
- Firefighting resources will be on stand-by while HAMET operations are conducted and transportation will be available for firefighting personnel;
- All pilots will be briefed on the mitigation requirements prior to HAMET missions.

Based on field surveys and supporting documents, the US Army has determined that the HAMET operations will have no appreciable effect on federally-listed species or federally-designated critical habitat, and no effect on biological resources, within the project area.

This assessment and supporting documents satisfy US Army responsibilities under Section 7(c) of the Endangered Species Act at this time. The US Army will continue to remain aware of any change in the status of these species or critical habitat, and will be prepared to re-evaluate potential project impacts if necessary.

Point of contact to discuss this no effect determination is Peter Peshut, 808-969-1966, peter.peshut@us.army.mil.

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References

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IMPC-HI-PS 04 April 2011

MEMORANDUM FOR RECORD

SUBJECT: Hawaiian Hoary Bat Surveys for HAMET Environmental Assessment

Surveys to assess potential available treeland roosting habitat and potential foraging habitat for the federally listed Hawaiian hoary bat (ope'ape'a, *Lasiurus cinereus semotus*) were conducted on 02 March 2011 at Mauna Loa landing zones LZ 1, LZ 2 and LZ 3, and on 03 March 2011 at Mauna Kea landing zones LZ 4, LZ 5 and LZ 6, by Rogelio Doratt, MSc. Doratt surveys for bat habitat were coincidental with arthropod surveys at these LZs. Observations for bat habitat were also made during the botanical surveys of 23 and 24 February 2011 (see Evans and Peshut MFR 30 March 2011), and during avifauna surveys of 02 and 03 March 2011 (see Schnell and Peshut MFR 04 April 2011). Surveys were conducted to determine the potential for bat presence in the general vicinity of the proposed LZs. The purpose of the surveys was to support the Environmental Assessment for High Altitude Mountainous Environmental Training (HAMET) that is proposed as an enduring training requirement for the Combat Aviation Brigade of the US Army 25th Infantry Division, Hawaii.

Mauna Kea LZs are on State of Hawaii land in the Mauna Kea Forest Reserve. Mauna Loa LZs are on State of Hawaii land in the Mauna Loa Forest Reserve. Landing zone geographic coordinates are given in Table 1. Landing zones are shown graphically in Figure 1. Each LZ is a graded or natural lava area approximately 30 x 30 m.

Table 1. Landing Zone Geographic Coordinates

Landing Zone	Latitude (N)	Longitude (W)	Elevation (ft)
Mauna Loa LZ1	19° 36' 05.64"	155° 28' 14.64"	7889
Mauna Loa LZ2	19° 36' 00.48"	155° 28' 37.74"	8049
Mauna Loa LZ3	19° 34' 32.10"	155° 29' 21.78"	8955
Mauna Kea LZ4	19° 49' 26.24"	155° 31' 23.51"	11,208
Mauna Kea LZ5	19° 49' 28.31"	155° 31' 47.00"	11,324
Mauna Kea LZ6	19° 49' 12.11"	155° 31' 16.31"	11,539

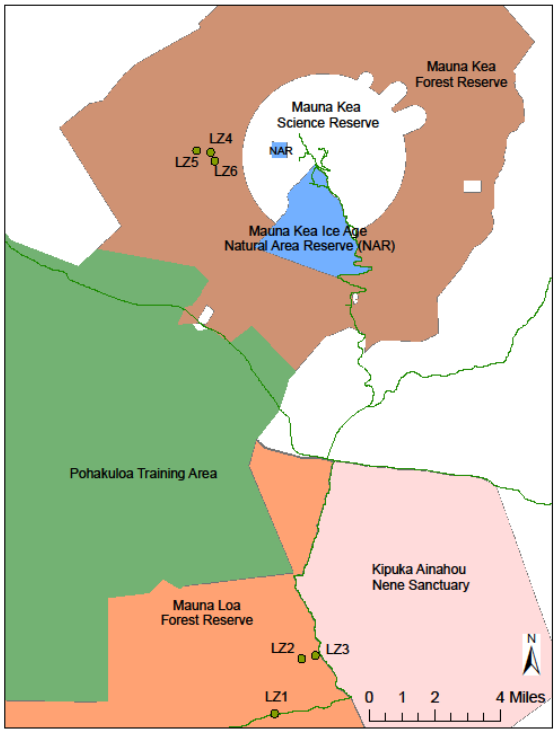

Figure 1. Mauna Kea and Mauna Loa HAMET Landing Zones

The bat habitat survey area for each LZ included a square 200 m on each side, centered on the geographic coordinates of respective LZs, as described for the arthropod and botanical surveys. Additional bat habitat survey area for each LZ was coincidental with avifauna surveys, and was a circle of 610 m (2000 ft) radius centered on the geographic coordinates of respective LZs, as described for the avifauna surveys.

Potential impacts to Hawaiian hoary bats as a result of HAMET operations are limited to noise and airstrike. Noise and airstrike potential were evaluated based on the expected presence of bats within the region of the LZs during HAMET activities. The potential for bat presence was evaluated based on available treeland roosting habitat and foraging habitat in the vicinities of the LZs.

Because of LZ elevations (see Table 1) and the complete absence or extremely low density of vegetation found within all LZ surveyed areas, bat presence is expected to be rare and bat density is expected to be extremely low in LZ areas during HAMET operations.

Hawaiian hoary bats are more frequently associated with roosting and foraging within forest structure rather than open habitat (kepler and Scott, 1990; Jacobs, 1994). Work conducted by the US Geological Survey (Biological Resources Division) indicates that bats are widely distributed throughout Hawaii Island in habitats with tree cover, including native and non-native forests, agricultural areas, and even some semi-urban areas (F. Bonaccorso, personal communication, 2006; Uyehara and Wiles, 2009). Hawaiian bats are insectivorous and nocturnal foragers, feeding in flight at elevations up to ~500 feet above ground level (Jacobs, 1996). Since insect density is generally associated with vegetation density, and given bat preference for roosting in forested habitat, it is reasonable to assume that bat roosting and foraging activity are greater in vegetated habitat than in open habitat dominated by barren lava. Jacobs (1994) observed that of 81 bats studied, 44% were observed foraging in native vegetation (ohia lowland forest) and 25% were observed foraging in either exotic vegetation or mixed vegetation. This supports the proposition that bats are more often associated with vegetated habitat at lower elevations, rather than open barren lava habitat at higher elevations.

Most recorded observations for bats are between sea level and 7,500 feet (Kepler and Scott, 1990; Jacobs, 1994; US FWS, 1998). Although bats have been recorded at elevations as high as 13,200 feet (Tomich, 1974), these must be considered as extremely rare and exceptional events.

For the surveyed areas of the Mauna Kea LZs there was no vegetation of height greater than 3 feet. The Mauna Kea LZs and surrounding areas are devoid of vegetation except for occasional widely-spaced grass clumps and small ferns and plants that grow in the lee of rocks. Therefore, there is no potential available treeland roosting habitat for bats in the vicinity of the Mauna Kea LZs. The density of insects at the Mauna Kea LZs is expected to be extremely low because of the elevation and sparse vegetation, and it is therefore extremely unlikely that the Mauna Kea LZs provide even marginal foraging habitat for bats.

The surveyed areas for the Mauna Loa LZs are located on largely barren substrate composed of ~55% aa and ~45% pahoehoe lava types. Approximately 62% of the substrate is less than 750 years old and with very little vegetative cover. Shrub cover is sparse (~10%) with very few shrubs greater than 3 feet in height. Trees greater than 3 feet in height are extremely rare in the region of the Mauna Loa LZs. Therefore, there is very little potential available treeland roosting habitat for bats in the vicinity of the Mauna Loa LZs. The density of insects at the Mauna Loa LZs is expected to be low because of the sparse vegetation, and it is therefore unlikely that the Mauna Loa LZs provide favorable foraging habitat for bats.

Given the lack of preferred roosting habitat among all LZ areas, daytime presence of roosting bats at any LZ is considered to be improbable, and therefore no daytime noise impact on bats is expected for any LZ. Foraging bats in transit across LZs is possible during nighttime hours, although this is extremely unlikely for the Mauna Kea LZs. For the Mauna Loa LZs, it is impossible to estimate the frequency of nighttime transits without extensive surveys. However, given the elevations (> 7500 feet) and the expanses of barren lava in the region of the Mauna Loa LZs, the number of transiting bats is expected to be very low. Moreover, nighttime training constitutes only a small part of the HAMET operations.

Airstrike as a result of HAMET operations was not considered to be of concern for Hawaiian hoary bats. Most HAMET activities are scheduled for daylight hours when bats are roosting in the forested areas of the island. Moreover, airstrikes are extremely rare for military aircraft in Hawaii overall, with only two airstrikes documented between 2001-2010 for all Army aircraft flights in the state of Hawaii (Peter Mansoor, CW4, personal communication, 2011).

Surveys and the literature support that the presence of Hawaiian hoary bats in significant numbers is unlikely for proposed HAMET operational areas. Extremely low density of bats during nighttime operations, or complete absence of bats during daytime operations, is to be reasonably expected for all LZs. The potential for noise or airstrike impacts on bats as a result of HAMET activities is therefore considered to be minimal.

Contact Peter Peshut, 808-969-1966, peter.peshut@us.army.mil, to discuss this matter further.

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IMPC-HI-PS 04 April 2011

MEMORANDUM FOR RECORD

SUBJECT: Wekiu Bug and Invasive Ant Surveys for HAMET Environmental Assessment

Surveys for the Mauna Kea endemic Wekiu bug *(Nysius wekiuicola)* and invasive ants were conducted on 02 March 2011 at Mauna Kea landing zones LZ 4, LZ 5 and LZ 6, by Rogelio Doratt, MSc, and Jesse Eiben, PhD (candidate). The purpose of the surveys was to support the Environmental Assessment for High Altitude Mountainous Environmental Training (HAMET) that is proposed as an enduring training requirement for the Combat Aviation Brigade of the US Army 25th Infantry Division, Hawaii.

The Wekiu bug is a small, wingless, scavenger insect known only from the summit region of Mauna Kea, Hawaii (11,500 - 13,792 ft, Figure 1). In 1999, the Wekiu bug was listed by the US Fish and Wildlife Service as a candidate species; i.e., potential to be listed for protection under the Endangered Species Act, depending on further scientific evidence that shows that protection under federal statute is necessary to reduce the potential for extinction.

Wekiu bugs reside on loose cinder cones comprised of tephra rocks (fragmental material produced by a volcanic eruption) that have a high proportion of interstitial space. Wekiu bugs emerge to the ground surface during the day to feed on dying or dead insects carried by winds from lower elevations (Ashlock and Gagné, 1983; Howarth, 1987; Eiben and Rubinoff, 2010). Since 2002, Wekiu bug surveys have been conducted on the summit of Mauna Kea, primarily in the Mauna Kea Science Reserve and the Mauna Kea Ice Age Natural Area Reserve (Englund et al., 2002; Porter and Englund, 2006; University of Hawaii, 2009). Surveys at Mauna Kea LZs were conducted to assess if the distribution of the Wekiu bug includes these areas that are considered potential Wekiu bug habitat, i.e., loose cinder cones at elevations ~11,500 ft).

Potential impacts to the Wekiu bug as a result of HAMET operations on Mauna Kea are disturbance of habitat and the introduction of invasive ant species.

Mauna Kea LZs are on State of Hawaii land in the Mauna Kea Forest Reserve. Landing zone geographic coordinates are given in Table 1. Landing zone locations in relation to known and potential Wekiu bug habitat are shown in Figure 1. Each Mauna Kea LZ is an undisturbed natural lava area approximately 100 x 100 ft.

Table 1. Landing Zone Geographic Coordinates

Landing Zone	Latitude (N)	Longitude (W)	Elevation (ft)
Mauna Kea LZ4	19° 49' 26.24"	155° 31' 23.51"	11,208
Mauna Kea LZ5	19° 49' 28.31"	155° 31' 47.00"	11,324
Mauna Kea LZ6	19° 49' 12.11"	155° 31' 16.31"	11,539

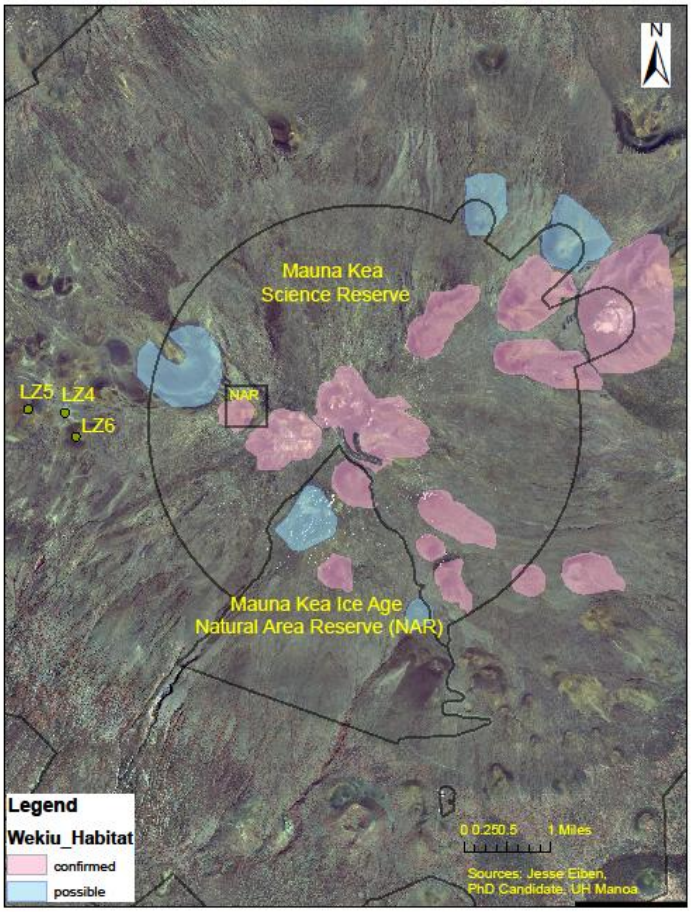

Figure 1. Mauna Kea HAMET landing zones and confirmed and possible Wekiu bug habitat.

The introduction and the establishment of invasive insect predators and competitors, especially ants, are a concern for Hawaii's native biota. World wide, ants are recognized as a major cause of native species extinctions. This is especially important for Hawaii, where native biota evolved in the absence of native ant species (Cole et al., 1992; Gillespie and Reimer, 1993; Krushelnycky and Gillespie, 2008). Predator ants could potentially decimate Wekiu bug populations on Mauna Kea due to direct predation or indirectly due to competition for wind-borne detritus. As an example, on Haleakala, Maui, the distribution of Argentine ants (*Linepithema humile*) has nearly reached the 10,500 ft summit, and has drastically altered the species assemblages of insect fauna there (Krushelnycky and Gillespie 2008). Therefore, surveying for ants at Mauna Kea LZs is considered to be an appropriate tool to assess the likelihood of Wekiu bug presence. If ants are present, then Wekiu bugs would almost certainly not be present, due to aggressive competition and predation by the ants.

For the invasive ants survey, the survey area included a circle of 100 m radius, centered on the geographic coordinates of respective LZs (Figures 2 and 3), similar to that described for the botanical surveys (see Evans and Peshut MFR 30 March 2011).

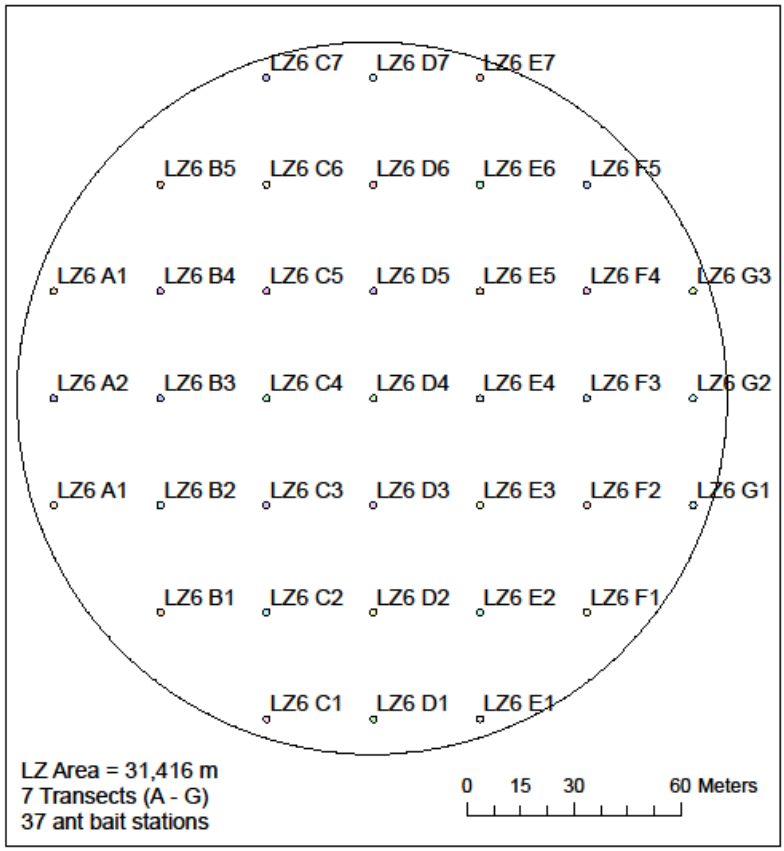

Figure 2. Schematic diagram of Mauna Kea LZ 6 ant bait station design.

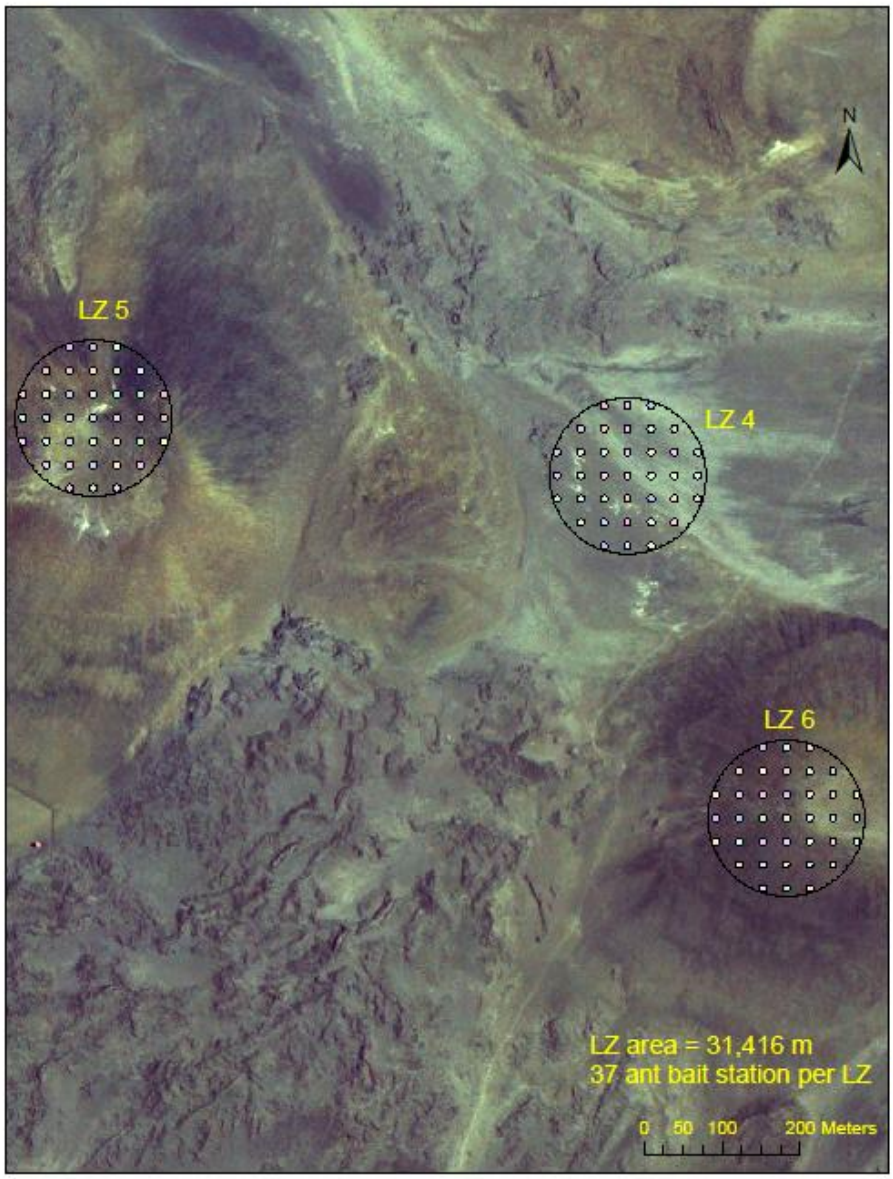

Figure 3. Overall Mauna Kea landing zones and ant bait station locations.

Each LZ survey had an area of 31,416 m^2 (~8 acres) with 37 ant bait stations. Bait stations were placed 30 m apart in 7 parallel transects at 30 m apart. A total of 111 ant bait stations were deployed at the Mauna Kea LZs. Bait stations were constructed of 40 ml polystyrene clear vials (8 cm x 2.8 cm), and filled with a 1:1 mixture of corn syrup and tuna (~1 teaspoon each), and ~1/2 teaspoon of peanut butter smeared inside the side of the vial (Photo 1). Bait stations were inspected and collected between 1-3½ hours after deployment.

Photo 1. Ant bait station at Mauna Kea LZ6- E4.

No ants were found in ant bait stations during the survey period. At this time, these results are considered indicative, but not conclusive. The short duration of the surveys, and the late-winter season and associated cold temperatures, are factors that may have limited surveyors' ability to determine ant presence. Extended duration surveys will be conducted in the April-June time frame in an attempt to confidently determine the presence or absence of invasive ant species at the Mauna Kea LZs.

Since ant presence or absence is used as a potential indicator of Wekiu bug presence or absence, the status of ants at Mauna Kea LZs is not a direct factor for assessing impacts from HAMET operations. The ant surveys do, however, provide a baseline for further study. Importation of ants to the Mauna Kea LZs as a result of HAMET operations is to be avoided. Aircraft inspection and cleaning protocols are in place, and must be implemented prior to missions. Ant survey baseline data will be useful to provide assurances that protocols are adhered to.

For the Wekiu bug, Eiben indicates that the survey period and season allow for only indicative interpretations of results. A conclusive determination of Wekiu bug presence or absence at the Mauna Kea LZs will be pursued via extended duration surveys in the April-June time frame (see Appendix A). However, Eiben states that the summits of the cinder cones at LZ 5 and LZ 6 do not appear to be preferable Wekiu bug habitat, even if the bugs were eventually found on other areas of the cinder cones that are more favorable habitat. Eiben states further that LZ4 is not likely to be Wekiu bug habitat due

to the flat terrain and ash/dust characteristics of the substrate. Moreover, it must be noted that the elevations of the Mauna Kea LZs are at or below the known elevation range of the Wekiu bug.

At this time, the Pohakuloa Natural Resources Office has determined that surveys for invasive ants and the Wekiu bug indicate that HAMET operations are likely to have little or no negative consequences to Wekiu bug populations in the regions of the Mauna Kea LZs. Results from surveys planned for the April-June time frame will be used to refine this assessment of the status of the Wekiu bug and ants in the region of the proposed LZs.

Contact Peter Peshut, 808-969-1966, peter.peshut@us.army.mil, for clarifications or to discuss this matter further.

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Appendix A

Results of the Proposed HAMET Site Evaluation for the Wekiu Bug (*Nysius wekiuicola*): March 2, 2011

Jesse Eiben

SUMMARY

The wekiu bug (*Nysius wekiuicola* Ashlock and Gagné) is a small, wingless, scavenger lygaeid bug found only in the summit region of Mauna Kea, Hawaii. This insect is a candidate for listing under the Endangered Species Act. A small survey was conducted to look for wekiu bug activity and broadly assess if the area is possibly habitable to the wekiu bug in the area proposed for HAMET Army helicopter training and landing zones. No wekiu bugs were found during the 3-4 hour field survey. The entire cinder cone habitats of the Landing Zones (LZ) are consistent with wekiu bug habitats at similar elevations on the northeast and east slopes of Mauna Kea. The actual proposed locations of the helicopter touch down areas (subset of the cinder cones) are not consistent with high quality wekiu bugs habitat. The trapping effort was minimal and is insufficient to assess the presence or absence of wekiu bugs at any of the cinder cones or near the LZs. Additionally, the wekiu bug is quite rare during the winter months, and the populations do not appear to increase or become detectable until late March. This small study should be used to gauge the likelihood of high quality habitat and inform direct effects on wekiu bugs by the proposed helicopter activity.

Methods:

A 3-4 hour sampling regime on March 2, 2011 with the use of 20 baited attractant live traps designed for monitoring the presence and absence of the wekiu bug, was used to inform part of the biological assessment of proposed sites for an Army high elevation helicopter landing site on Mauna Kea, Hawaii. A total of 20 traps in 10 locations across an elevation and aspect gradient around the highest elevation cinder cone proposed as a landing site (LZ-6) were placed and inspected 3-4 hours after initial placement (Figure 1, 2). A live pitfall trap design very similar to those described by Englund et al. (2002) and Pacific Analytics (2006) was used to attract wekiu bugs. The modifications in design are as follows. Two 10oz clear plastic cups were used for each trap. The upper cup was punctured with one small hole in the bottom center through which a small absorbent wick made of tissue (Kimtech Science) was pushed. A small amount of water was poured into the bottom of the lower reservoir cup. The attractant shrimp paste was placed in the upper cup contacting the wick, on a few small pieces of rock in the cup, smeared on the side of the cup, and on a cap rock. The traps were dug into the available ground substrate attempting to achieve a depth where moisture was present in the ash layer. The lip of the cup was not necessarily placed flush with ash layer, and there was no wire mesh surround to provide structure

surrounding the cups. This cup design has been successful for attracting and capturing wekiu bugs from 2007-2010 (Eiben and Rubinoff 2010). All 10 sites selected for sampling used a pair of traps within 5 meters of each other in different microhabitat types (ex. large rock jumble vs. ash layer near the surface) to attempt to sample the true diversity of the habitat.
Additionally, a 20 minute baited site observation period was used to assess wekiu bug activity. Shrimp paste was placed on the surface of approximately 20 rocks within one square meter. This site was monitored visually for 20 minutes for wekiu bug activity. Finally, temperatures were recorded by data loggers (HOBO by Onset Cor., type U12-008) every 10 minutes in the substrate microhabitat (the substrate surface, below the surface (~7cm below), and at the top of the ash/dust layer (~30cm)) during the survey time period to compare to published accounts of wekiu bug thermal preferences in their confirmed habitat range.

Discussion and Conclusion:
The two cinder cones proposed as helicopter landing sites (LZ-5 and LZ-6) do appear structurally and ecologically similar to cinder cones that host confirmed wekiu bug populations (Photos 1, 2 and 3). The slopes are steep, with many contiguous area of cinder rock tephra at least eight inches deep before the dust/ash layer of the substrate is reached. The cinder cones are also nearly devoid in plant life except for at least 3 species of lichen, one species of moss, and some grasses and ferns at the base of the cinder cones. There were also live and dead prey items identical to what is found in confirmed wekiu bug habitats. The prey items that were easily identified during this survey without collection were, labybird beetles, scarab beetles, carabid beetles, large blow flies, other *Nysius* seed bugs (*Nysius palor*), small fungus gnats, and braconid wasps (Photo 4). The temperature variability recorded showed a microhabitat temperature change from the sun illuminated surface to the shaded deep ash layer, through which the wekiu bug can not dig deeper. Additionally, a temperature probe was used to observe the direct temperature of rock surface, and the maximum temperature obtained was 40.4 ºC (104.8 ºF). The total available temperatures available for thermoregulation was consistent with the temperatures recorded in wekiu bug habited cinder cones during this 4 hour recording span (Eiben and Rubinoff 2010). Broadly, the cinder cones in this study were consistent with wekiu bug habitat. The lowest recorded elevation of a wekiu bug is 11,400ft (Figure 3). If the LZ cinder cones in this study are inhabited by wekiu bugs, we expect the densities to be low, and perhaps ephemeral, as has been shown at lower elevations in the east and northeast cinder cones on Mauna Kea.

The sampling regime used in this study was insufficient to definitively assess the presence or absence of wekiu bugs. Wekiu bugs have often been captured in greater numbers during late March, April and May than during the summer, fall and winter (Eiben and Rubinoff 2010). The short sampling period (hours) in this study may have not been enough time for wekiu bugs to find the shrimp paste baited traps from any distance. Also, because of the comparative rarity of

wekiu bugs in the winter and at lower elevations than the summit proper, a much greater effort would be necessary to declare the wekiu bug absent from any location on Mauna Kea.

The type of substrate found directly at the proposed landing zones at the summit of both cinder cones (LZ-5, LZ-6) does not appear to be prime wekiu bug habitat even if the bugs were to found on the cinder cones as a whole. The rocks at the summits of the cinder cones are large and closely packed, resembling the type of dense and solid rock that emerged as magma underneath glaciers, with ash visible at the surface between these dense angular rocks. That type of rock arrangement has been repeatedly demonstrated as not hosting wekiu bug populations (Photo 5). The type of loose cinder 20-30cm deep that wekiu bugs prefer is found on the slopes and at the base of the cinder cones (Photo 5). LZ-4 is found in a flat ash/dust region between cones, and it is not likely wekiu bug habitat. Wekiu bugs have very rarely (only at extremely low numbers in the 1980s) been found in the glacial till areas between cinder cones on the east side of Mauna Kea.

The only arthropod positively identified as an endemic resident of Mauna Kea was the as yet undescribed wolf spider, *Lycosa* sp. One living individual was observed near the summit of the east side of the LZ-6 cinder cone. Multiple molted exoskeletons were found while placing wekiu bug traps (Photo 7).

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Figure 1. Overview of all proposed Mauna Kea helicopter landing zones and wekiu bug sampling

Figure 2. Overview map of Wekiu bug sampling locations on LZ-6 cinder cone

Figure 3: Overview of Mauna Kea summit showing proposed HAMET LZ (4-6) (green) and confirmed cinder cones with wekiu bugs (blue)

Table 1. Temperatures recorded in 20cm deep cinder on the west slope of the LZ-6 cinder cone near trap WB 1(A+B)

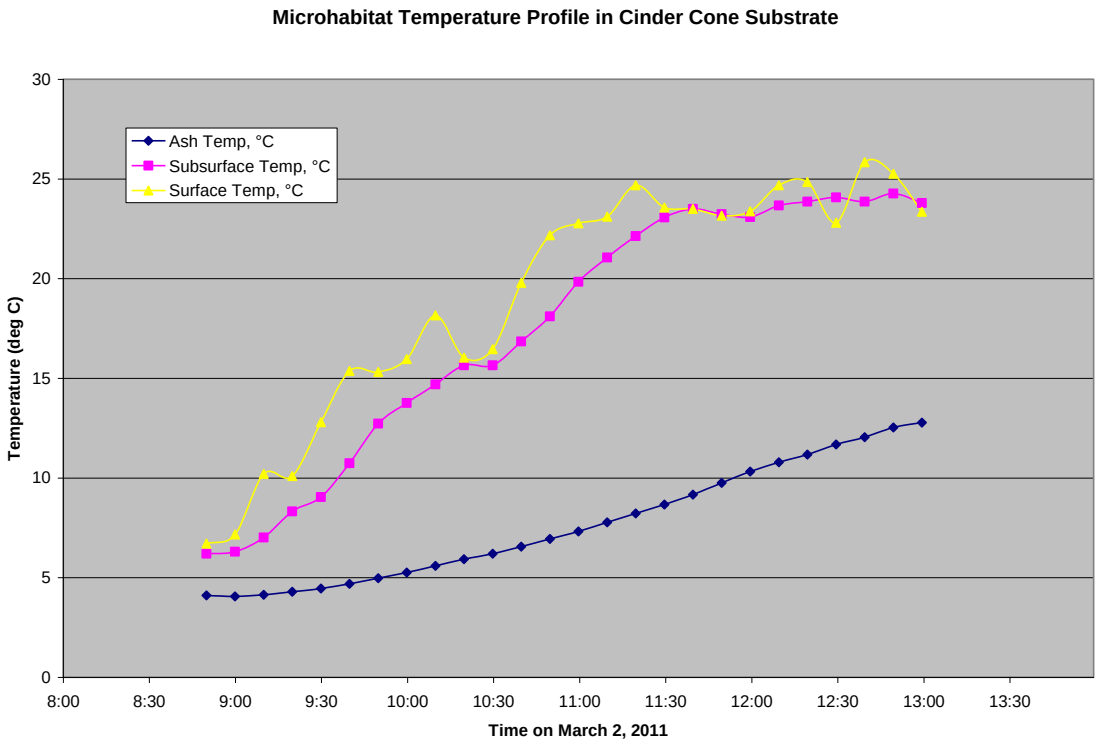

Photo 1: West slope of cinder cone at LZ-6. The substrate is very similar to wekiu bug habitat in its structure, depth and composition at a similar elevation on the east side of Mauna Kea (~11,400ft)

Photo 2: East slopes of cinder cone at LZ-5. The substrate is very similar to wekiu bug habitat in its structure, depth and composition at a similar elevation on the east side of Mauna Kea (~11,400ft)

Photo 3: Low elevation Wekiu bug habitat on the east slop of Mauna Kea (at VLBA dish telescope, ~11,400ft)

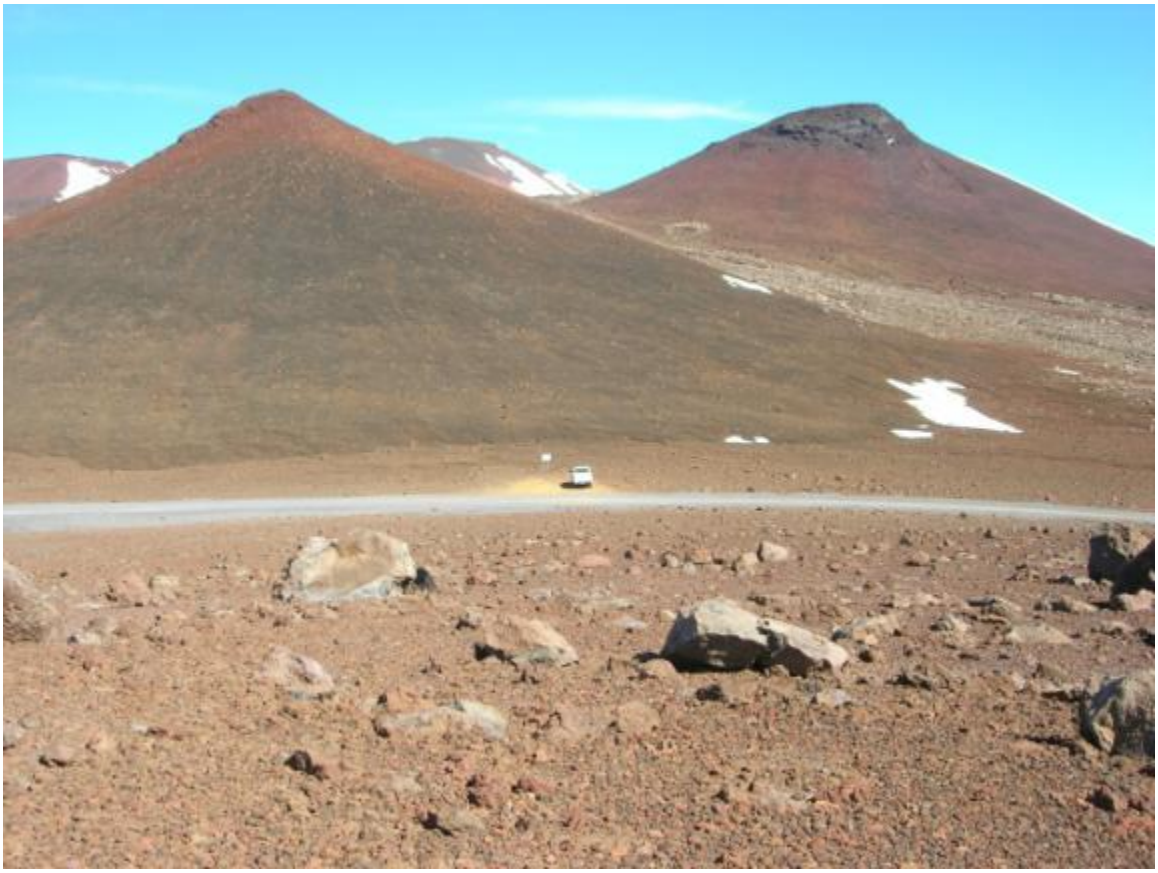

Photo 4: Dead or moribund potential wekiu bug prey items. Pictured- Left, ladybird beetle. Right, *Nysius palor*

Photo 5: Top- LZ-6 cinder cone summit rocks and visible ash. Bottom- LZ-6 cinder cone east slope rocks.

Photo 6: Endemic Mauna Kea wolf spider (*Lycosa* sp.) molted exoskeleton

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IMPC-HI-PS 10 June 2011

MEMORANDUM FOR RECORD

SUBJECT: Wekiu Bug and Invasive Ant Surveys for HAMET Environmental Assessment

Follow-up surveys to the preliminary 02 March 2011 surveys for the Mauna Kea endemic *Nysius wekiuicola* (Wekiu bug) were conducted on 08 June 2011 at Mauna Kea landing zones LZ 5 and LZ 6, by Rogelio Doratt, MSc and Jesse Eiben, PhD (candidate). Mauna Kea LZ 4 does not present a favorable Wekiu bug habitat and therefore it was not surveyed for the bug. Wekiu bugs are known to occur only in the summit areas of Mauna Kea, therefore no survey were conducted for the Mauna Loa LZs (Ashlock and Gagné 1983, Howarth 1987, and Eiben and Rubinoff 2010).

Preliminary surveys for invasive ant species were conducted on 02 March 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6 by Doratt, Martha Kawasaki, BSc, Sarah Knox BSc, and Lena Schnell, BA, and on 03 March 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3 by Doratt, Schnell, Kawasaki, Joseph Kern, BSc, and Daniel Brown, MSc. Follow-up surveys for invasive ants were conducted on 31 May 2011 at Mauna Loa LZ 1, LZ 2 and LZ 3 by Doratt, Springer Kaye, MSc, and Kahea Nihipali, and on 06 June 2011 at Mauna Kea LZ 4, LZ 5 and LZ 6 by Doratt, Kawasaki, and David Dukevares.

The purpose of these surveys was to support the Environmental Assessment for High Altitude Mountainous Environment Training (HAMET) that is proposed as an enduring training requirement for the Combat Aviation Brigade of the US Army 25th Infantry Division, Hawaii.

The importance of surveying for the Wekiu bug and invasive ants at the Mauna Kea and Mauna Loa LZs is presented in detail in previous correspondence (see Peshut and Doratt Memorandum For Record 04 April 2011). Disturbance of habitat and the introduction of invasive ant species are potential impacts to the Wekiu bug as a result of HAMET operations on Mauna Kea. The spread of invasive ant species is widely recognized as a serious concern for many ecological systems, especially isolated pacific islands such as Hawaii that host a great number of endemic species that are not adapted to predatory arthropods (Cole et al. 1992, Gillespie and Reimer 1993, Krushelnycky and Gillespie 2008).

Mauna Kea LZs are on State of Hawaii land in the Mauna Kea Forest Reserve. Landing zone locations in relation to known and potential Wekiu bug habitat are shown in Figure 1. Each Mauna Kea LZ is an undisturbed natural lava area approximately 150 x 150 ft. Mauna Loa LZs are on State of Hawaii land in the Mauna Loa Forest Reserve. Each Mauna Loa LZ is a previously disturbed area of graded crushed lava approximately 150 x 150 ft. All landing zones are shown in Figure 2. Landing zone geographic coordinates and elevations are given in Table 1.

Table 1. Landing Zone Geographic Coordinates

Landing Zone	Latitude (N)	Longitude (W)	Elevation (ft)
Mauna Loa LZ1	19° 36' 05.64"	155° 28' 14.64"	7889
Mauna Loa LZ2	19° 36' 00.48"	155° 28' 37.74"	8049
Mauna Loa LZ3	19° 34' 32.10"	155° 29' 21.78"	8955
Mauna Kea LZ4	19° 49' 26.24"	155° 31' 23.51"	11,208
Mauna Kea LZ5	19° 49' 28.31"	155° 31' 47.00"	11,324
Mauna Kea LZ6	19° 49' 12.11"	155° 31' 16.31"	11,539

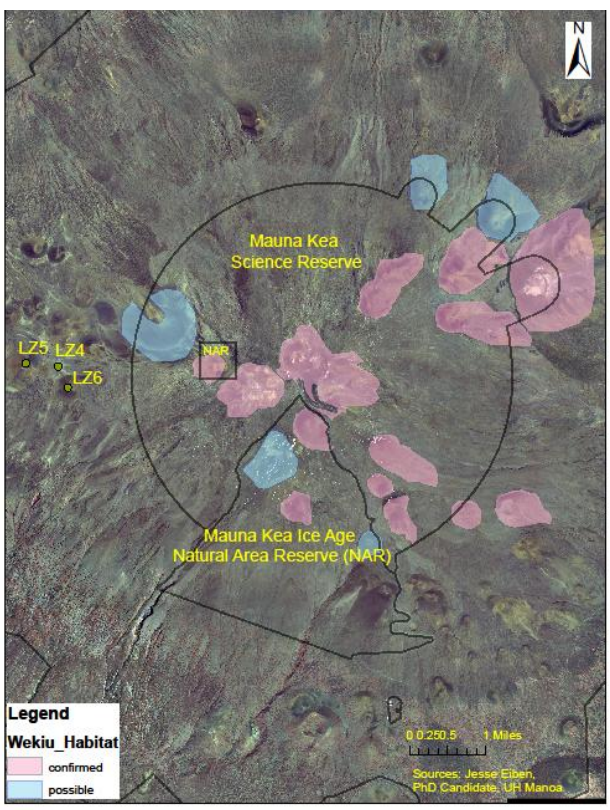

Figure 1. Mauna Kea HAMET LZs and confirmed and possible Wekiu bug habitat.

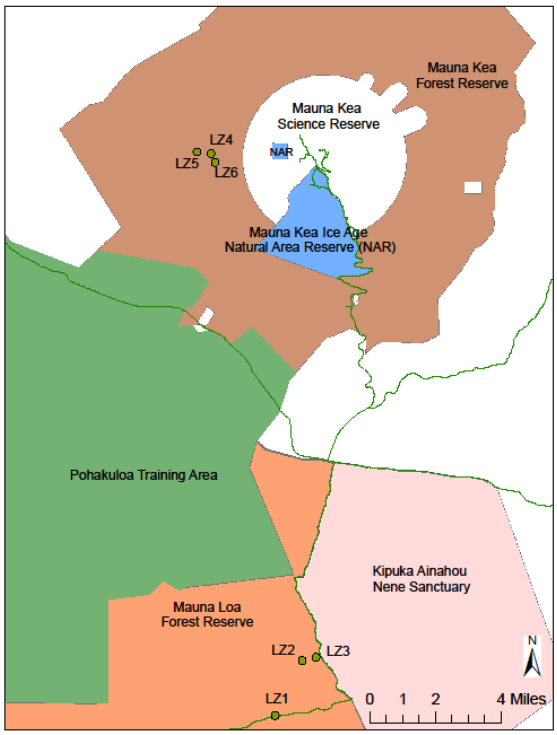

Figure 2. Mauna Kea and Mauna Loa HAMET Landing Zones

Wekiu bug survey methods and findings are presented in Appendix A.

For the invasive ants survey, the survey area for each LZ included a circle of 100 m radius, centered on the geographic coordinates of respective LZs (Figures 3-5), similar to that described for the botanical surveys (see Peshut and Evans Memorandum For Record 30 March 2011).

Each LZ survey included an area of 31,416 m^2 (~8 acres) with 37 ant bait stations per LZ. Bait stations were placed 30 m apart in 7 parallel transects at 30 m apart. A total of 111 ant bait stations were deployed for each LZ. Bait stations were constructed of 40 ml polystyrene clear vials (8 cm x 2.8 cm), and filled with a 1:1 mixture of corn syrup and tuna (~1 teaspoon each), and ~1/2 teaspoon of peanut butter smeared inside the side of the vial (Photo 1). Bait stations were inspected and collected between 1-2½ hours after deployment. Argentine ants, the target survey species, are known to forage extensively at temperatures between 12.5-30° C (Markin, 1970). Temperatures for Mauna Loa surveys were ~17-20° C. See Appendix A for Mauna Kea temperatures.

For all LZs of Mauna Kea and Mauna Loa, no ants were found in bait stations during the survey period. Based on the preliminary and final surveys, these results are considered conclusive that no ant species occur at the proposed LZs.

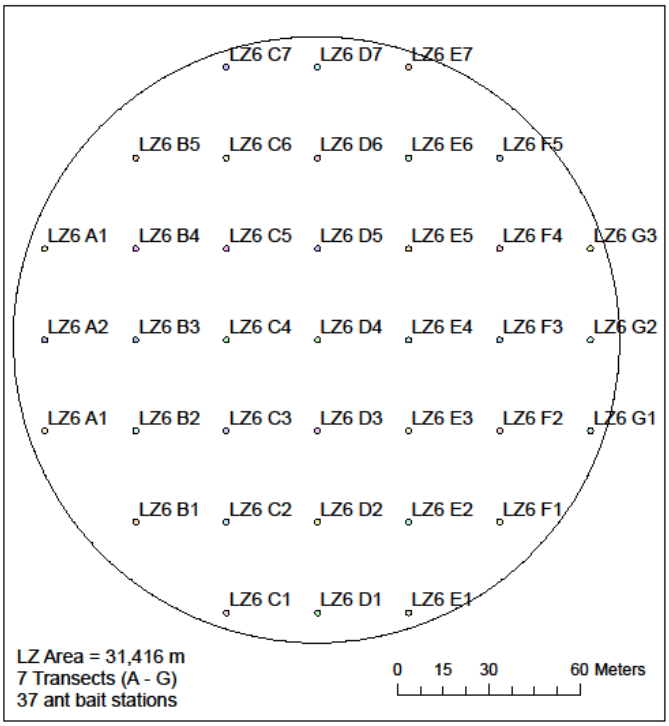

Figure 3. Schematic diagram of Mauna Kea LZ 6 ant bait station design.

Figure 4. Mauna Kea landing zones and ant bait station locations.

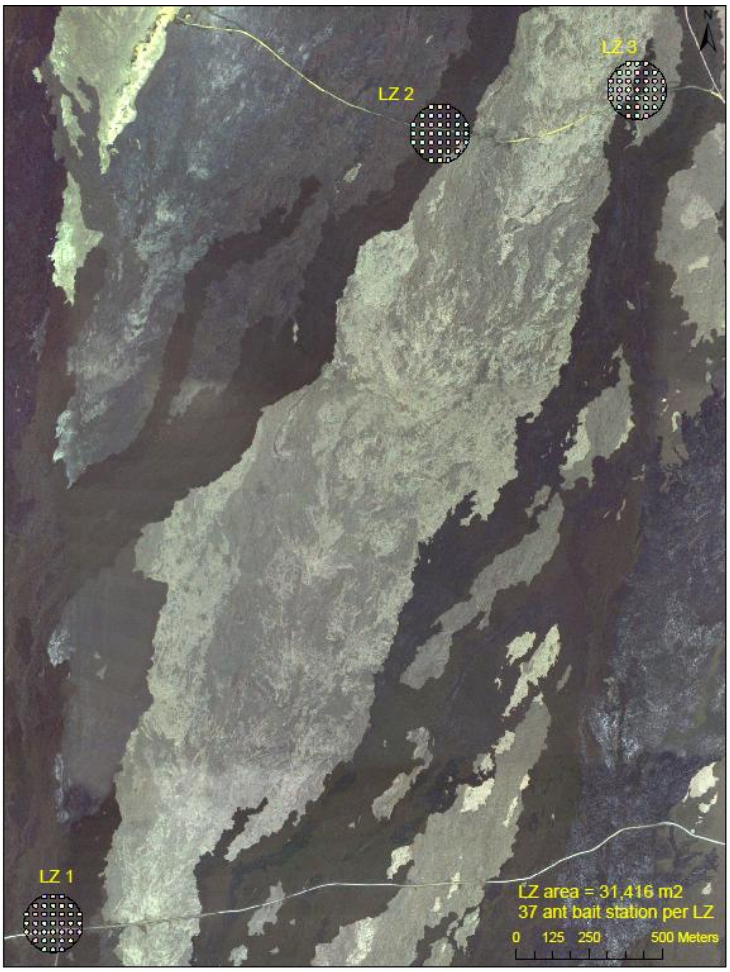

Figure 5. Mauna Loa landing zones and ant bait station locations.

Photo 1. Ant bait station at Mauna Kea LZ6- E4.

At this time, the Pohakuloa Natural Resources Office has determined that surveys for invasive ants and the Wekiu bug indicate that HAMET operations are likely to have no negative consequences to Wekiu bug populations in the regions of the Mauna Kea LZs. Furthermore, inspection and cleaning protocols proposed for helicopters during HAMET operations will limit the potential for distribution of invasive ants to Mauna Kea and Mauna Loa LZs.

Contact Peter Peshut, 808-969-1966, peter.peshut@us.army.mil, for clarifications or to discuss this matter further.

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Appendix A

Results of the Proposed HAMET Site Evaluation for the Wekiu Bug (*Nysius wekiuicola*): June 8, 2011

Prepared for Pohakuloa Training Area Wildlife Team (Rogelio Doratt)

Prepared by:
Jesse Eiben, M.S.

SUMMARY

The wekiu bug (*Nysius wekiuicola* Ashlock and Gagné) is a small, wingless, scavenger lygaeid bug found only in the summit region of Mauna Kea, Hawaii. This insect is a candidate for listing under the Endangered Species Act. This report details a second survey to look for wekiu bug activity and broadly assess if the area is possibly habitable to the wekiu bug in the area proposed for HAMET Army helicopter training and landing zones. No wekiu bugs were found during this second 3-4 hour field survey (other survey conducted in March, 2011). The entire cinder cone habitats of the Landing Zones (LZ) are consistent with wekiu bug habitats at similar elevations on the northeast and east slopes of Mauna Kea. However, wekiu bugs do not appear to be distributed as widely on the west side of Mauna Kea, and their presence below 12,000ft is doubtful, and this survey supports that. The actual proposed locations of the helicopter touch down training areas (subset of the cinder cones, at the summits) are not consistent with high quality wekiu bug habitat. Our June wekiu bug trapping effort was sufficient to assess wekiu bug activity in the vicinity of traps, and no wekiu bugs were trapped or observed. The direct impact on wekiu bug populations on Mauna Kea from helicopter use of the landing zones (LZ-5 and LZ-6, specifically) would be insignificant and could not cause negative population level consequences to the species.

Methods:
A 3-4 hour sampling regime on June 8, 2011 with the use of 22 baited attractant live traps designed for monitoring the presence and absence of the wekiu bug, was used to inform part of the biological assessment of proposed sites for an Army high elevation helicopter landing site on Mauna Kea, Hawaii. A total of 22 traps in 22 locations across an elevation and aspect gradient around the cinder cones proposed as a landing site (LZ-5 and LZ-6) were placed and inspected 2-3 hours after initial placement (Figure 1, 2). A live pitfall trap design very similar to

those described by Englund et al. (2002) and Pacific Analytics (2006) was used to attract wekiu bugs. The modifications in design are as follows. One 10oz clear plastic cup was used for each trap, as the traps were not in place long enough to necessitate a water source for any potential wekiu bug captures. The attractant shrimp paste was placed on a few small pieces of rock in the cup, smeared on the side of the cup, and on a cap rock. The traps were dug into the available ground substrate attempting to achieve a depth where moisture was present in the ash layer and to stabilize the cup. The lip of the cup was not necessarily placed flush with ash layer, and there was no wire mesh surround to provide structure surrounding the cups. This cup design has been successful for attracting and capturing wekiu bugs from 2007-2011 (Eiben and Rubinoff 2010). All 22 sites selected for sampling were selected to include a loose assortment of different sized cinder tephra rocks as preferred by wekiu bugs where they are found in other areas of Mauna Kea. Additionally, a 30 minute baited site observation period was used to assess wekiu bug activity. Shrimp paste was placed on the surface of approximately 10 rocks within one square meter. This site was monitored visually for 30 minutes for wekiu bug activity. Finally, temperatures were recorded by data loggers (HOBO by Onset Cor., type U12-008) every 10 minutes in the substrate microhabitat (the substrate surface, below the surface (~7cm below), and at the top of the ash/dust layer (~30cm)) during the survey time period to compare to published accounts of wekiu bug thermal preferences in their confirmed habitat range (Figure 3).

Discussion and Conclusion:

No wekiu bugs were found during this survey. The two cinder cones proposed as helicopter landing sites (LZ-5 and LZ-6) do appear structurally and ecologically similar to cinder cones that host confirmed wekiu bug populations (Photos 1, 2 and 3). The slopes are steep, with many contiguous area of cinder rock tephra at least eight inches deep before the dust/ash layer of the substrate is reached. The cinder cones are also nearly devoid in plant life except for at least 3 species of lichen, one species of moss, and some grasses and ferns at the base of the cinder cones. There were also live and dead prey items identical to what is found in confirmed wekiu bug habitats. The prey items that were easily identified during this survey without collection were, labybird beetles (Coccinellidae), large blow flies (Calliphoridae), other *Nysius* seed bugs (*Nysius palor*, Lygaeidae), large amounts of small fungus gnats (Sciaridae) (Photo 4), and braconid wasps (Braconidae). The temperature variability recorded showed a microhabitat temperature change from the sun illuminated surface to the shaded deep ash layer, through which the wekiu bug can not dig deeper (Figure 3). Additionally, a temperature probe was used to observe the direct temperature

of rock surface, and the maximum temperature obtained was 36.2 ºC. The total available temperatures available for thermoregulation was consistent with the temperatures recorded in wekiu bug habited cinder cones during this 4 hour recording span (Eiben and Rubinoff 2010). Broadly, the cinder cones in this study were consistent with wekiu bug habitat, but wekiu bugs are unlikely to be found here due to recorded absence of wekiu bugs below 12,000ft on the west side of Mauna Kea. The lowest recorded elevation of a wekiu bug is 11,400ft on the east side of Mauna Kea (Figure 2). If the LZ cinder cones in this study are inhabited by wekiu bugs, which is unlikely, we expect the densities to be low, and perhaps ephemeral, as has been shown at lower elevations in the east and northeast cinder cones on Mauna Kea. Therefore, any impact from helicopter rotor wash or physical helicopter touch down on the cinder cone summits on the species would be insignificant.

The sampling regime used in this study was sufficient to definitively assess the presence or absence of wekiu bugs in the vicinity of traps. In areas where wekiu bugs are present, and during times when the temperature in the substrate is above ~15ºC (Figure 3), wekiu bugs are readily observed (by experienced observers). Wekiu bugs have been captured in their known habitats above ~12,000ft on Mauna Kea since April 30th, 2011 (personal observation, and personal communication with Bishop Museum personnel June 5-9), so wekiu bugs would have been active if they were present. As with any rare animal, in areas with extremely low density it may be impossible to definitively indicate its absence from a locality. However, in this case, it is unlikely that wekiu bugs are present, and even if they were present, the proposed helicopter training would not affect the population.

The type of substrate found directly at the proposed landing zones at the summit of both cinder cones (LZ-5, LZ-6) does not appear to be prime wekiu bug habitat even if the bugs were to found on the cinder cones as a whole. The rocks at the summits of the cinder cones are large and closely packed, resembling the type of dense and solid rock that emerged as magma underneath glaciers, with ash visible at the surface between these dense angular rocks. Other areas that have smaller rock tephra are also compacted, since there is no steep slope to allow the gravity induced loose rock size sorting that creates wekiu bug preferred habitat. That type of rock arrangement has been repeatedly demonstrated as not hosting wekiu bug populations. The type of loose cinder 20-30cm deep that wekiu bugs prefer is found on the slopes and at the base of the cinder cones (Photo 2 and 3). LZ-4 is found in a flat ash/dust region between cones, and it is not likely wekiu bug habitat. Wekiu bugs have very rarely (only at extremely low

numbers in the 1980s) been found in the glacial till areas similar to LZ-4 substrate between cinder cones on the east and west sides of Mauna Kea.

The only two arthropods positively identified as an endemic resident of Mauna Kea was the as yet undescribed wolf spider, *Lycosa* sp. (Photo 4), and one specimen of an *Agrotis* sp., moth. These species are widely distributed on all substrate types in the alpine stone desert from ~11,000ft-13,796ft on Mauna Kea.

I do not see any direct significant impact on wekiu bugs or other resident arthropods from helicopter landing activity in the proposed landing zones (LZ-4, LZ-5, LZ-6). The only possible threat to resident arthropods in the proposed landing zones could be ecosystem change from introducing new weeds or arthropods (notably ants). This potential threat is easily mitigated with simple cleanliness standards for crew and equipment with vehicle washing or brushing off any debris from other landing zones.

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Figure 1. Overview of all proposed Mauna Kea helicopter landing zones and wekiu bug sampling

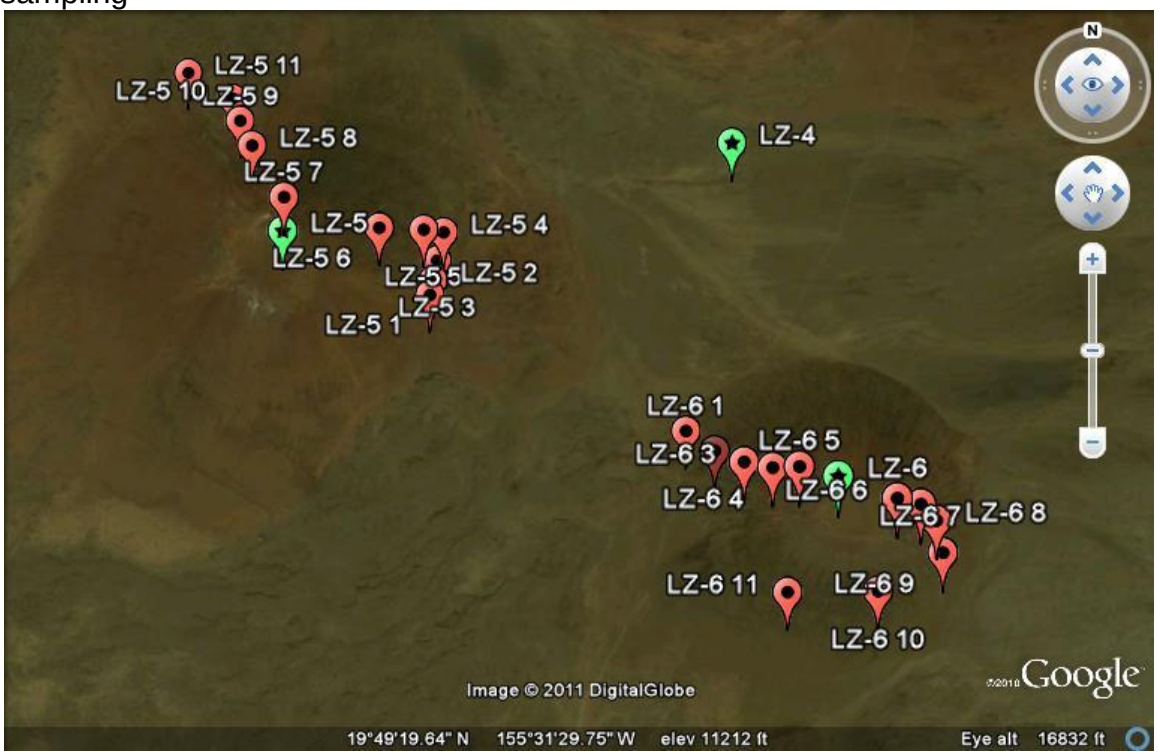

Figure 2: Overview of Mauna Kea summit showing proposed HAMET LZ (4-6) (green) and confirmed cinder cones with wekiu bugs (blue)

Figure 3. Temperatures recorded in 20cm deep cinder on the west slope of the LZ-6 cinder cone near trap LZ-6 2

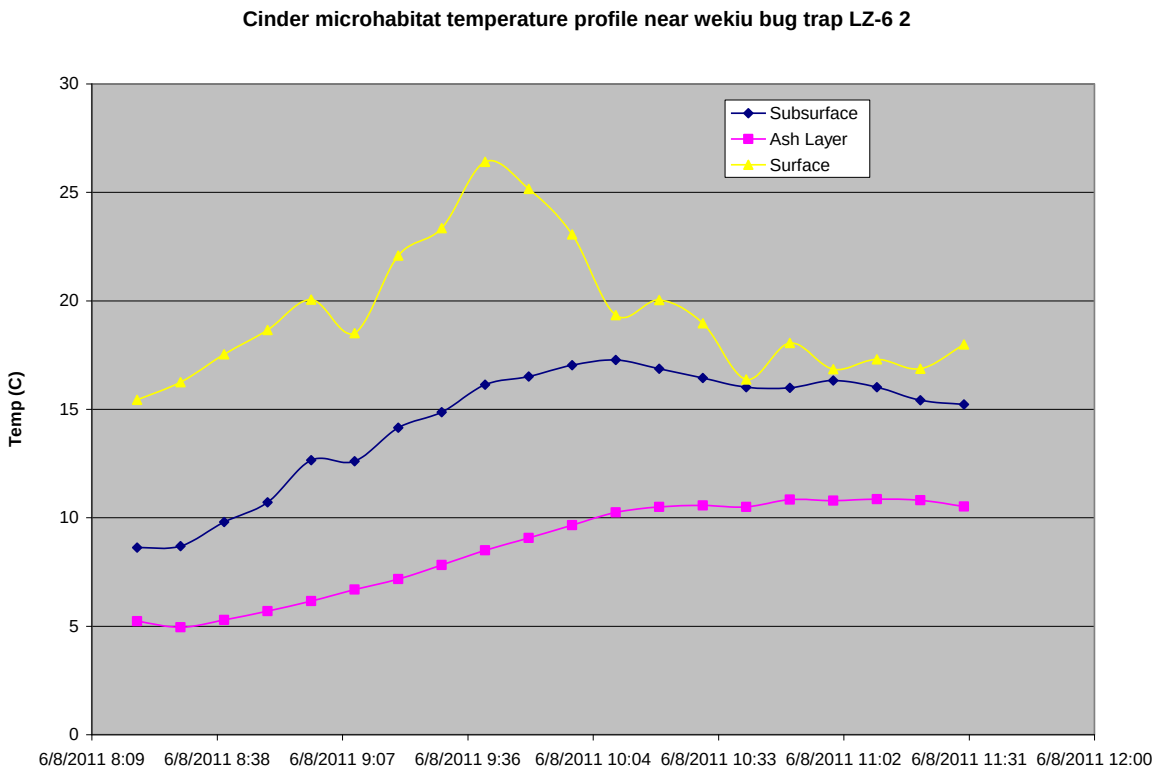

Photo 1: West slope of cinder cone at LZ-6. The substrate is very similar to wekiu bug habitat in its structure, depth and composition at a similar elevation on the east side of Mauna Kea (~11,400ft), but is likely too low in elevation on the west side of Mauna Kea to support wekiu bugs

Photo 2: East slopes of cinder cone at LZ-5. The substrate is very similar to wekiu bug habitat in its structure, depth and composition at a similar elevation on the east side of Mauna Kea (~11,400ft), but is likely too low in elevation on the west side of Mauna Kea to support wekiu bugs

Photo 3: Low elevation Wekiu bug habitat on the east slope of Mauna Kea (at VLBA dish telescope, ~11,400ft) *not near HAMET LZ, comparison only

Photo 4: *Lycosa* sp. and Sciaridae flies (very small, flies are visible behind the spider abdomen in the cup) found in a wekiu bug trap

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IMPC-HI-PS 30 March 2011

MEMORANDUM FOR RECORD

SUBJECT: Botanical Surveys for HAMET Environmental Assessment

Botanical surveys were conducted 23 February 2011 at Mauna Loa landing zones LZ 1, LZ 2 and LZ 3, and 24 February 2011 at Mauna Kea landing zones LZ 4, LZ 5 and LZ6, by Steven Evans, MSc, and Lena Schnell, BA. Surveys were conducted to determine the presence of federally listed plant species and to assess overall vegetation in the general vicinity of the LZs. The purpose of the surveys was to support the Environmental Assessment for High Altitude Mountainous Environmental Training (HAMET) that is proposed as an enduring training requirement for the Combat Aviation Brigade of the US Army 25th Infantry Division, Hawaii.

Mauna Kea LZs are on State of Hawaii land in the Mauna Kea Forest Reserve. Mauna Loa LZs are on State of Hawaii land in the Mauna Loa Forest Reserve. Landing zone geographic coordinates are given in Table 1. Landing zones are shown graphically in Figure 1. Each LZ is a graded or natural lava area approximately 30 x 30 m.

Table 1. Landing Zone Geographic Coordinates

Landing Zone	Latitude (N)	Longitude (W)	Elevation (ft)
Mauna Loa LZ1	19° 36’ 05.64”	155° 28’ 14.64”	7889
Mauna Loa LZ2	19° 36’ 00.48”	155° 28’ 37.74”	8049
Mauna Loa LZ3	19° 34’ 32.10”	155° 29’ 21.78”	8955
Mauna Kea LZ4	19° 49’ 26.24”	155° 31’ 23.51”	11,208
Mauna Kea LZ5	19° 49’ 28.31”	155° 31’ 47.00”	11,324
Mauna Kea LZ6	19° 49’ 12.11”	155° 31’ 16.31”	11,539

The survey area for each LZ was selected as a square, 200 m on each side, centered on the geographic coordinates of respective LZs. Survey area dimensions were based on the height and distance of aircraft from the LZ center, along an anticipated line of

aircraft approach, where aircraft rotorwash begins to affect the ground surface. Rotorwash effect height = 1.5x rotor diameter (Peter Mansoor, CW4, personal communication, 2011). For the largest aircraft (worst-case scenario), the CH-47 Chinook, the rotorwash is first felt at the ground surface when the aircraft is 90 feet above ground level (AGL). For HAMET operations, CH-47 aviators will approach LZs so that aircraft will reach 90 feet AGL at 100 m from the LZ center. Thus, vegetation on the ground will not experience rotorwash until the CH-47 aircraft is 100 m from the LZ center. All other aircraft potentially used for HAMET have rotorwash effects that are less than the CH-47 Chinook. For the UH-60 Blackhawk, rotorwash is first felt at ground level when the aircraft is ~80 feet above the ground surface. For the OH-58 Kiowa, rotorwash is not experienced at ground level until the aircraft is ~50 feet above the ground surface. Therefore, a botanical survey area out to 100 m from the LZ center encompassed all areas where vegetation was expected to experience helicopter rotorwash.

For each LZ survey area, GIS software was used to establish a series of 200 m transects spaced 10 m apart, with navigational waypoints established at the ends of each transect. Transect spacing of 10 m is standard practice for botanical surveys at Pohakuloa Training Area, and is based on terrain, vegetation density, and visibility.

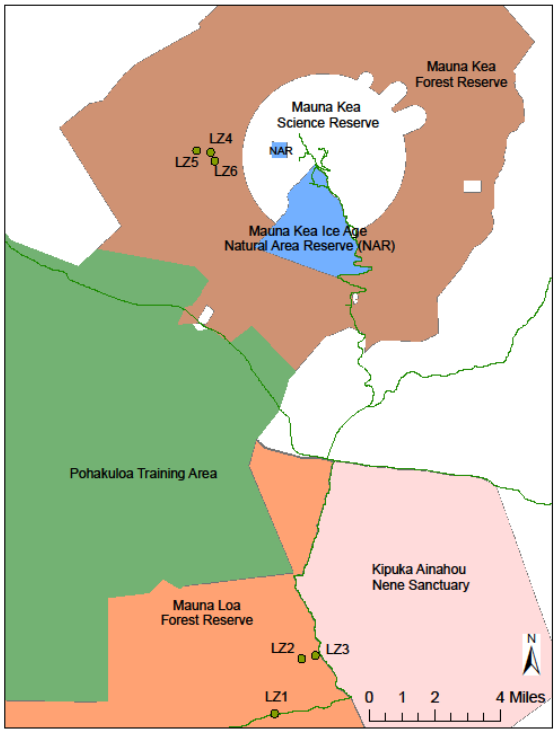

Figure 1. Mauna Kea and Mauna Loa HAMET Landing Zones

In the field it was found that the sparse to absent vegetation at the HAMET LZs did not necessitate surveyor spacing of 10 m. Therefore, surveyors were spaced 20 m apart, i.e., along every other transect, inclusive of transects on the edge of the survey areas. For all survey days, for all LZs, field conditions were suitable for conducting surveys and visibility was extremely good.

Mauna Loa LZ 1 is a previously disturbed area adjacent to the paved Mauna Loa Observatory Road. LZ 1 consists of crushed lava pieces (½-4 inch) with no visible entrained fine-grained material (Figure 2). The substrate surrounding LZ 1 is barren a‘a lava from the 1899 Mauna Loa flow. No plants were found at LZ 1 or within the LZ 1 survey area (Figure 3).

Figure 2. LZ 1 – Material Size

Figure 3. LZ 1 - Surrounding Substrate and Lack of Vegetation

Mauna Loa LZ 2 is a previously disturbed area adjacent to an unimproved spur road off the Mauna Loa Observatory Road. LZ 2 consists of crushed lava pieces (½-3 inch) with no visible entrained fine-grained material (Figure 4). The substrate surrounding LZ 2 is a‘a lava from the 1899 Mauna Loa flow (Figure 5). Bulldozer trails and disturbed areas are found within the LZ 2 survey area. No plants were found at LZ 2. Overall vegetation density in the LZ 2 survey area was extremely low, with mostly bare ground (Figure 5). Plant species found within the LZ 2 survey area were limited to:

Coprosma ernoidioides – common native
Leptecophyla tameiameiae – common native
Polypodium pellucidum – common native
Vaccinium reticulatum – common native

Figure 4. LZ 2 – Material Size

Figure 5. LZ 2 - Surrounding Substrate and Vegetation

Mauna Loa LZ 3 is a previously disturbed area adjacent to an unimproved spur road off the Mauna Loa Observatory Road. LZ 3 consists of crushed lava pieces (½-3 inch) with no visible entrained fine-grained material (Figure 6). The substrate surrounding LZ 3 is a‘a lava from the 1899 Mauna Loa flow and prehistoric pahoehoe lava flows (Figure 7).

There were no plants present within LZ 3. Similar to other Mauna Loa LZs, the overall density of vegetation within the LZ 3 survey area is extremely low, with mostly bare ground (Figure 7). Plant species found within the LZ 3 survey area were limited to:

Aspleinium adianthum-nigrum– common native
Aspleinium trichomanes subsp. *densum* – common native
Carex wahuensis – common native
Coprosma ernoidioides – common native
Dodonaea viscosa – common native
Dubautia ciliolata subsp. *ciliolata* – common native
Leptecophyla tameiameiae – common native
Pelea ternifolia – common native
Polypodium pellucidum – common native
Senecio madagascariensis – introduced
Tetramolopium humile – common native
Trisetum glomeratum – common native
Vaccinium reticulatum – common native
Wikstroemia phillyreifolia – common native

Figure 6. LZ 3 – Material Size

Figure 7. LZ 3 - Surrounding Substrate and Vegetation

Mauna Kea LZ 4 is located on a saddle between two cinder cones on which LZ 5 and LZ 6 are located. LZ 4 consists of undisturbed native substrate (½-3 inch) with a moderate amount of entrained fine-grained material (Figure 8). The surrounding substrate for LZ 4 consists of rocky cinder soil and a few rocky outcrops. There is evidence that the substrate is constantly reworked by the natural forces of wind, rain, ice, and snow. Similar to other LZs, the overall density of vegetation within the LZ 4 survey area is extremely low, with mostly bare ground (Figure 9). Plant species found within the LZ 4 survey area were limited to:

Asplenium adianthum-nigrum – common native
Pelea ternifolia – common native
Picris hieracioides – introduced
Verbascum thapsus – introduced

Figure 8. LZ 4 – Material Size

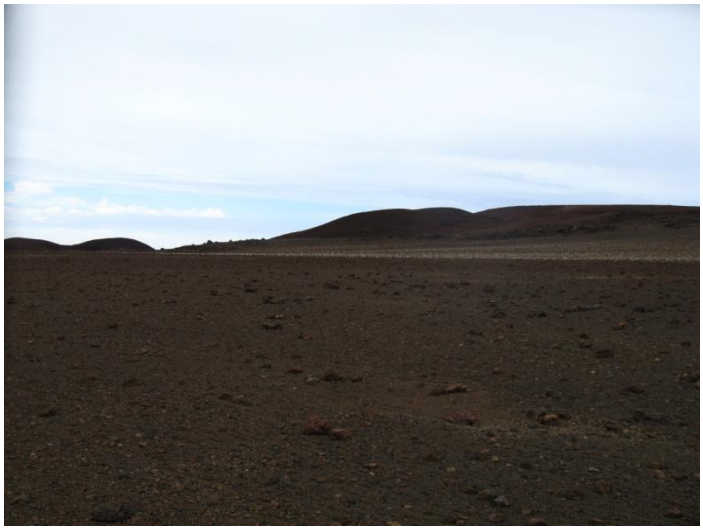

Figure 9. LZ 4 - Surrounding Substrate and Vegetation

Mauna Kea LZ 5 is located on the summit of a cinder cone ~800 m west of LZ 4 and consists of undisturbed native material (½-6 inch) with little to no entrained fine-grained material (Figure 10). The survey area of LZ 5 consists of loose cinder, rocks, and rocky outcrops. The only species present within the LZ 5 survey area was:

Trisetum glomeratum – common native

Plant density at LZ 5 is extremely low to absent, with mostly barren lava (Figure 11).

Figure 10. LZ 5 – Material Size

Figure 11. LZ 5 - Surrounding Substrate and Vegetation

Mauna Kea LZ 6 is located on the summit of a cinder cone ~500 m south of LZ 4 and consists of undisturbed native lava (½-6 inch) with little or no entrained fine-grained material, and some hard pan (Figure 12). Overall, the survey area consists of loose cinder, rocks, and rocky outcrops. Vegetation density at LZ 6 is extremely low to absent, with mostly barren lava substrate (Figure 13). Species within the LZ 6 survey area were limited to:

Pelea ternifolia – common native
Trisetum glomeratum– common native

Figure 12. LZ 6 – Material Size

Figure 13. LZ 6 - Surrounding Substrate and Vegetation

No federally listed or candidate species were located at any of the LZs or within any LZ survey area for any of the proposed HAMET sites. To corroborate these findings, records from the Hawaii Natural Heritage Program indicate that there are no rare or protected plant species recorded within any of the Mauna Kea and Mauna Loa LZ survey areas (R. Kam, personal communication, 2011).

The nearest threatened and endangered species to the Mauna Kea LZs is the federally-listed Mauna Kea Silversword (*Argyroxiphium sandwicense* subsp. *sandwicense*) located approximately 2600 m west of the Mauna Kea LZs. These plants are well beyond the range of effects from HAMET operations. On Mauna Loa, endangered species occur on Pu'u Huluhulu (outplanted) located ~8000 m from the LZs, and at Pohakuloa Training Area 21, ~6000 m from the LZs. These plants on Mauna Loa are well beyond the range of effects produced from HAMET operations.

Wind generated from helicopter approaches and landings at LZs is not considered to be of concern for vegetation. Helicopter rotorwash velocities at ground level are within the range of typical wind conditions on Mauna Kea and Mauna Loa. According to records, average wind speeds at the Mauna Loa Observatory range from 11-45 mph, with gusts to ~54 mph (A. Colton, personal communication, 2011). On Mauna Kea, average wind speed is ~57 mph (Carrasco and Sarazin, 2003), with a maximum recorded wind speed of 126 mph (Bely, 1987).

Rotorwash velocity from the OH-58 Kiowa at lift-off is up to 56 mph at a distance of 20 feet from the aircraft (Leese and Knight, 1974). This diminishes to less than the speed of prevailing winds at LZs at ~40 feet from the aircraft. The CH-47 Chinook generates a rotorwash velocity of up to 127 mph at lift-off at a distance of 50 feet from the aircraft (Leese and Knight, 1974), but this diminishes to the speed of prevailing winds at LZs at

a distance of ~160 feet from the aircraft. Technical information for UH-60 Blackhawk rotorwash was not found, but it is reasonable to expect that rotorwash for this aircraft will diminish to the speed of prevailing winds at a distance somewhere between where the smaller OH-58 and the larger CH-47 winds diminish to prevailing wind speeds.

Rotorwash wind speeds in the immediate vicinity of HAMET aircraft are generally within the range of Category 1 (weak) hurricane conditions, which is described as having minimal damage potential for vegetation (Simpson, 1974). Although rotorwash winds can exceed 100 mph in close proximity to aircraft during landings and takeoffs, the duration of these winds will be short and winds will be highly localized.

Because of the complete absence or extremely low density of vegetation found at the LZs, the minimal amount of fine material within the LZ substrate available to generate dust, and the highly localized and short duration of the action, it is not expected that HAMET operations will have any long-term impacts to vegetation at LZs. It is anticipated that the impacts to common and introduced vegetation from HAMET operations will not exceed impacts from natural conditions on Mauna Kea and Mauna Loa.

Contact Peter Peshut, 808-969-1966, peter.peshut@us.army.mil, to discuss this matter further.

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IMPC-HI-PS 04 April 2011

MEMORANDUM FOR RECORD

SUBJECT: Hawaiian Avifauna Surveys for HAMET Environmental Assessment

Surveys to assess potential impacts to avifauna (bird) species that are protected under the Endangered Species Act and the Migratory Bird Treaty Act were conducted on 02 March 2011 at Mauna Loa landing zones LZ 1, LZ 2 and LZ 3, and on 03 March 2011 at Mauna Kea landing zones LZ 4, LZ 5 and LZ 6, by Lena Schnell, BA, Daniel Brown, MSc, Sarah Knox, BSc, Joseph Kern, BSc and Bridget Frederick, BSc. Surveys were conducted to determine bird presence and habitat use in the general vicinity of the proposed LZs. Surveys were conducted to support the Environmental Assessment for High Altitude Mountainous Environmental Training (HAMET) that is proposed as an enduring training requirement for the Combat Aviation Brigade of the US Army 25th Infantry Division, Hawaii.

Mauna Kea LZs are on State of Hawaii land in the Mauna Kea Forest Reserve, in the vicinity of the Mauna Kea Science Reserve. Mauna Loa LZs are on State of Hawaii land in the Mauna Loa Forest Reserve, adjacent to the Kipuka Ainahou Nene Sanctuary. Approximately 20% of the Mauna Loa LZ3 survey area is within the sanctuary. Landing zone geographic coordinates are given in Table 1. Landing zone locations are shown graphically in Figure 1. Each LZ is a graded or undisturbed lava area approximately 100 x 100 ft.

Table 1. Landing Zone Geographic Coordinates

Landing Zone	Latitude (N)	Longitude (W)	Elevation (ft)
Mauna Loa LZ1	19° 36’ 05.64”	155° 28’ 14.64”	7889
Mauna Loa LZ2	19° 36’ 00.48”	155° 28’ 37.74”	8049
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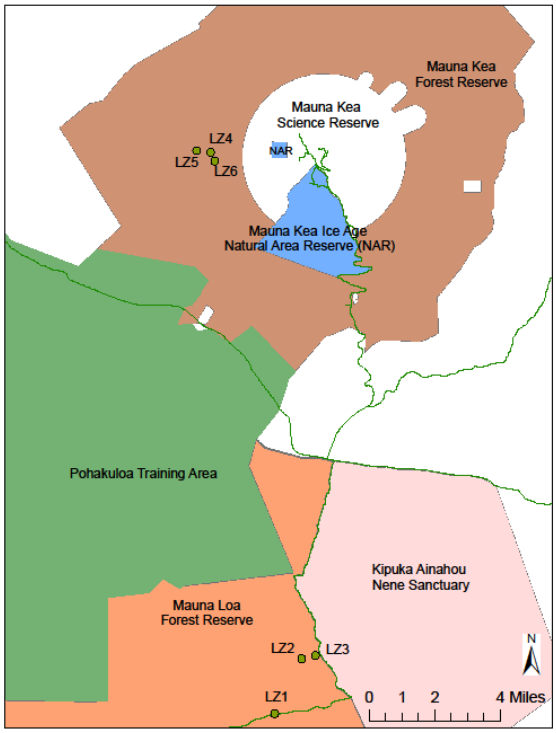

Figure 1. Mauna Loa and Mauna Kea HAMET Landing Zones.

Currently, Combat Aviation Brigade training is conducted for ~4500 man-hours of training annually in the Saddle region of Hawaii Island. HAMET operations are expected to increase training man-hours by approximately 30%.

Potential impacts to Hawaiian avifauna as a result of HAMET operations are limited to disturbance from noise, and airstrikes. Noise and airstrike potential were evaluated based on the expected presence of birds within the LZ survey areas during HAMET operations.

Airstrike as a result of HAMET operations was not considered to be of concern for Hawaiian avifauna. Most HAMET activities are scheduled for daylight hours when helicopters are visible as well as audible to birds. Avifauna in the vicinity of Mauna Kea LZs during nighttime operations is not anticipated. Avifauna in the vicinity of Mauna Loa LZs during nighttime operations is expected to be minimal. Bird airstrikes are extremely rare for military aircraft in Hawaii overall, with only two airstrikes documented between 2001-2010 for all Army aircraft flights in the state of Hawaii (Peter Mansoor, CW4, personal communication, 2011). Moreover, helicopters are typically slow-moving at the elevations of the LZs proposed for HAMET operations, due to unpredictable air mass

stability and decreased air density, which affect aircraft performance (Frank Tate, COL, personal communication, 2011).

Artificial light sources as a result of HAMET operations were not considered to be of concern for Hawaiian avifauna. Starlight may be important for seabird navigation towards the sea from a land mass, and bright artificial light sources are known to be hazardous to fledging Petrels (Simons and Hodges, 1988). Young birds may be confused by artificial light sources when navigating to sea for the first time. On Kauai Island, seabirds, including Petrels, are known to crash into artificial lights and become grounded, where they are subject to predation. In an area with little human development such as the Saddle region of Hawaii Island, artificial lights may pose a hazard to Petrels. Artificial light sources will not be placed at the LZs, as this is not consistent with realistic combat conditions (Frank Tate, COL, personal communication, 2011). Therefore, no impacts to seabirds from artificial light sources will occur.

The potential for noise disturbance was raised as a concern during the first public comment period for the HAMET Environmental Assessment (Dec 2010 – Jan 2011). The US Fish and Wildlife Service suggested that wildlife within the 60 dB noise contour might be negatively impacted by helicopter operations. A basis for using the 60 dB contour could not be justified from a review of the relevant scientific literature. Bowels and Wisdom (2005) indicated that a 60 dB (A) rule (hourly A-weighted L_{eq}) for birds was originally established to prevent masking of species-typical songs. They concluded that there is little evidence to support the effectiveness of the 60 dB rule for all noise-related impacts, and recommended that there should be further research prior to the 60 dB (A) rule becoming widely used for NEPA consultations.

Numerous studies on noise impacts to wildlife, including over flights from military aircraft such as helicopters, have been conducted in past decades. Although results cannot generally be applied across species, studies demonstrate that various species, from wading birds to raptors, co-exist with loud noises (see Appendix A). Although there is debate in the literature as to the effects from noise on the fitness of birds, many studies focus only on behavioral responses, which may not indicate physiological responses or animal fitness. The literature supports that many bird species live, breed, and raise young in areas with sound levels well over 80 dB. Birds may flush from nests when sound levels are high (generally > 80-100 dB), but generally return to their nests within minutes after the disturbance abates. Also, many studies indicate that birds habituate (display decreasing responses) to loud noises. An annotated bibliography on avifauna and noise is presented in Appendix A.

Although it is recognized that exceptions are possible among individual species, the 80 dB contour was selected as the reasonable noise level threshold of concern for disturbance of bird species for the purposes of this survey, based on the literature.

The survey area for each proposed HAMET LZ included a circle of radius 2000 feet, centered on the geographic coordinates of respective LZs. The radius of LZ survey areas was selected based on a noise contour of 80 dB for the CH-47 Chinook, the loudest aircraft proposed for HAMET operations (Table 2). The survey area for each LZ encompassed ~290 acres.

Table 2. Noise levels for HAMET helicopters[a].

	Decibels (dB (A))		
Slant Distance (ft)	CH-47 (Chinook)	UH-60 (Black Hawk)	OH-58 (Kiowa)
200	98	91	89
500	89	83	81
1,000	83	76	74
2,000	77	69	67

[a]Source: US Army (2010)

The Mauna Loa LZs and surveyed areas are located on young barren lava. Substrate composition varies within the survey areas, with ~55% aa and ~45% pahoehoe lava types. Approximately 62% of the lava within the survey areas is less than 750 years old, and has very little vegetation cover. The remaining 38% of the lava is greater than 1500 years old, and supports small stature native shrubs, several of which produce berries that provide food resources to many native bird species (Table 3). Shrub cover is sparse (≤ 10%), with most shrubs less than 3 feet in height, and confined to cracks in the lava where soil and organic matter have accumulated. Very few trees or shrubs greater than 3 feet tall are present within the survey areas of the Mauna Loa LZs.

Table 3. Berry-producing shrubs within Mauna Loa LZ survey areas.

Species	Common Name
Coprosma ernoidioides	Kukaenene
Leptecophyla tameiameiae	Pukiawe
Vaccinium reticulatum	Ohelo

Mauna Kea LZ 5 and LZ 6 are located on the summits of barren cinder cones. Mauna Kea LZ 4 is on flat terrain between LZ 5 and LZ 6, and consists of barren, rocky soil. The Mauna Kea LZs and surrounding area are essentially devoid of vegetation. Vegetation at these LZs is limited to occasional widely spaced grass clumps and a few small ferns and plants growing in the lees of rocks. There are little or no food resources for birds within the Mauna Kea LZ survey areas.

The principal Hawaiian bird species that were selected for surveys were based on species' status under the Endangered Species Act (ESA) and the Migratory Bird Treaty Act (MBTA). Upland game birds were also considered during avifauna surveys, even though these birds are not protected under federal law. Game birds are important to the local hunting community, and therefore constitute an important component of the biological resources of the HAMET operational area.

Hawaiian Petrel (*Pterodroma sandwichensis*) – Endangered (ESA)

The Mauna Loa LZs are located on the northeast slope of Mauna Loa, ~4 miles from known Petrel colonies in Hawaii Volcanoes National Park. Limited investigations suggest that Petrels use the Saddle region as a flyway from the west coast to the colonies along the Mauna Loa northeast rift zone in the park (Cooper et al., 1995).

The Mauna Kea LZs are located at high altitude, and do not appear to contain likely Petrel habitat. Mauna Kea LZ 5 and LZ 6 are located on the rim of cinder cones with extremely loose cinders which are not suitable for excavating burrows. Mauna Kea LZ 4 is a flat and exposed area with no slope in which to excavate burrows. Within the survey areas for all these LZs, however, there is some (minimal) potential Petrel habitat where a few rocky outcrops provide crevices, cracks and soil for excavating burrows.

The Hawaiian Petrel was once common in the Saddle region of Hawaii Island, as evidenced by the abundance of bones found in archaeological middens of ancient Hawaiians. Petrels nest only on the main Hawaiian Islands, with extant colonies on Maui, Hawaii, Kauai, Lanai and possibly Molokai. On Hawaii Island, existing colonies are found between 8200-9200 ft on Mauna Loa. Vegetation associated with Petrel colonies includes pukiawe (*Leptecophyla tameiameiae*), kukaenene (*Coprosma ernodeoides*), ohelo (*Vaccinium reticulatum*), and kupaoa (*Dubautia menziesii*), with vegetation cover usually <10% (Simmons and Hodges, 1998).

In colonies, birds use openings in the lava as burrows to raise their young. Breeding pairs visit their burrows briefly in February to initiate breeding season. Pairs then depart the colonies to feed at sea, usually by March, and return to the colony in late April or early May to lay eggs. Both parents assist with incubating and rearing. Young Petrels fledge from the colonies in October or November. Non-breeding birds also visit the

colony from May to August. Non-breeding birds call almost continuously within the colony during this period and are the portion of the population easiest to detect. It is assumed that healthy functional colonies will contain a non-breeding component. Surveys therefore typically focus on detecting calls from non-breeding birds from May to August.

Results presented below are considered substantially indicative at this time, although preliminary. Because surveys were conducted in March during a period of expected Petrel absence from the island, it was not possible to determine conclusively if the habitats investigated within the LZ surveyed areas support Petrel colonies. Surveys for all Mauna Loa and Mauna Kea LZs will be conducted again between May and August when non-breeding birds are expected to be present if there are extant colonies in the LZ survey areas. Suitable habitat within each LZ survey area will be surveyed a minimum of four times during the May-August period to maximize the potential for detecting Petrels. Trained observers will begin listening for Petrel calls at sampling sites 10 minutes prior to sundown and will remain until 9:30 pm. In addition, a recording system may be deployed to continuously record sound data.

Results from the preliminary March Petrel surveys are discussed below.

For the Mauna Loa LZs, habitat within the surveyed areas was examined for evidence of Petrel use. While each 100 x 100 ft LZ is located on barren aa lava, unsuitable for petrel colonies, each LZ survey area contained portions of suitable colony habitat. Specific to potential impact from rotorwash, a positive identification of potential petrel habitat was made within ~325 ft of Mauna Loa LZ 3 (the distance at which rotorwash from the largest aircraft will first be felt at ground level; see Peshut and Evans MFR 30 March 2011). If this area is eventually found to be occupied by petrels, helicopter rotrowash could potentially impact Petrels on the ground or flying over the area. It is assumed that birds would vacate the area as the helicopter approaches the LZ and then return once the disturbance is past.

HAMET operations will produce ~10 minutes of disturbance per LZ landing event. Helicopter noise and rotorwash may be attenuated within Petrel burrows. At Haleakala National Park it was found that the majority of Petrel burrows were more than 2 m deep and less than 10% were less than 1 m (Simons, 1985). In addition, Petrel nest chambers cannot typically be viewed from the entrance usually due to a bend in the burrow tunnel (Hu, 1996). Although burrow depth and configuration are not documented for Petrel colonies on Mauna Loa in Hawaii Volcanoes National Park, it is assumed that Petrels overall choose similar burrow characteristics. Petrels in burrows are therefore expected to be at last 1 m underground and around a tunnel bend. Thus, it is improbable that rotorwash will significantly impact Petrels within burrows. Similarly,

noise impacts to Petrels in burrows will be attenuated by overlying soil and rock. In support of this proposition, noise restrictions in Haleakala National Park limit construction noise levels at burrows within 80 m of a construction site to 83 dB (A), measured at five feet from the sound source during the Petrel incubation period (April-July). If Petrel burrows are found within a 325 ft radius of Mauna Loa LZ 3, similar restrictions may be necessary for HAMET operations.

For Mauna Kea LZs, Banko (1980a) summarizes Petrel occurrence on Mauna Kea from historic records, and from results from surveys conducted mostly on the eastern and southeastern flanks of the mountain between 1968 and 1970. Although a few birds were detected, Banko (1980a) did not locate any active colonies on Mauna Kea. No published surveys were found for the southwest slope of Mauna Kea where the HAMET LZs are located, but mummified Petrel remains are known from a cinder cone (puunanaha) that is down slope and within ~2½ miles of these LZs at ~8000 ft elevation. Petrel remains are also known from the south slope of Mauna Kea at a human habitation site above 11,000 ft. It is known that the Hawaiian Petrel was a preferred food of ancient Hawaiians, and given the elevation, it is possible that the Petrel remains at the 11,000 ft elevation were from human origin. In comparison, extant Petrel burrows are recorded as high as 9,976 ft in Haleakala National Park (Maui).

Potential Petrel habitat was found within ~325 ft of Mauna Kea LZ 5 where a rocky outcrop in the central bowl of the cinder cone could provide habitat for excavating burrows. If this area is occupied by Petrel, the impacts from helicopter rotorwash could potentially impact Petrel on the ground or flying over the area. It is highly unlikely, however, that Petrel occupy the HAMET LZ survey areas on Mauna Kea. Conclusive surveys during the May-August time frame will provide for a final determination.

As mitigation for the unlikely event that Petrels will have colonies in the vicinity of LZs, the Combat Aviation Brigade has indicated that the use of any LZ will be suspended for a period to be defined by the Pohakuloa Natural Resources Office, if the presence of a Petrel colony at or within the vicinity of any LZ is verified.

Band-Rumped Storm-Petrel (*Oceanodroma castro*) – Candidate (ESA)

Band-Rumped Storm-Petrels have habitat requirements and breeding season similar to the Hawaiian Petrel (Slotterback, 2002). Adult Storm-Petrels are believed to nest in burrows at high elevations, and lay eggs between May and June, with nestlings fledging in October. This species is found on the Hawaiian Islands only during breeding season. On Hawaii Island, Band-Rumped Storm-Petrels are often heard calling in or near Hawaiian Petrel colonies.

Band-Rumped Storm-Petrels are documented using habitat in the Saddle region (Pohakuloa Natural Resources Office, unpublished data). Birds were recorded a few nights in 2008, 2009 and 2010 between May and August at Puu Koli in southeastern PTA, ~4½ miles from the proposed HAMET LZs on Mauna Loa. At this time it is unclear how the birds are using this area. It can be assumed that Storm-Petrels use the Saddle region as a flyway to nesting habitat on the northeast rift zone on Mauna Loa, within the Hawaii Volcanoes National Park. Storm-Petrels are documented within the Hawaiian Petrel colonies in the National Park, and also at Red Hill cabin along the Mauna Loa summit access trail at ~10,000 ft elevation.

Potential impacts from HAMET training to Band-Rumped Storm-petrels will be similar to those described for the Hawaiian Petrel.

Because habitat assessments were conducted in March when Band-Rumped Storm-Petrels are expected to be at sea, it was not possible to determine if the habitat is currently used by these birds. Additional investigations will be conducted between May and August when non-breeding birds are present in colonies, and will follow protocols established for the Hawaiian Petrel surveys.

Newell's Shearwater (*Puffinus newelli*) – Endangered (ESA)

Newell's Shearwaters are colonial nesters coming ashore at night (Ainley et al., 1997). Colonies are often located at high elevations in remote areas with native vegetation on slopes of 65 degrees or greater. Breeding season begins in April, when birds prepare burrow sites. Birds then depart in late April and return in June to lay a single egg. Both parents incubate the egg. Most of the young fledge by November.

HAMET operations on Mauna Kea and Mauna Loa will not affect Newell's Shearwaters. On Hawaii Island, Newell's Shearwater colonies are limited to the Puna District (~25 miles southeast of Pohakuloa), the Hamakua coast (~25 miles northeast of Pohakuloa) and Waipio Valley (~20 miles northwest of Pohakuloa). No Newell's Shearwater colonies are known in the subalpine or alpine areas of Hawaii Island. Since Newell's Shearwater colonies are located near the coasts, inland flights through the Saddle region are probably rare and extremely unlikely during HAMET operations.

Hawaiian Goose (*Branta sandvicensis*) – Endangered (ESA)

The Hawaiian Goose (Nene) has adapted generally to a terrestrial life and does not require wetlands habitat (US FWS, 2004). Although Nene are known to occupy sites with open water, they seem to prefer grasslands, shrublands and dryland forests (Banko et al., 1999). There are an estimated 500 Nene on Hawaii Island. Breeding populations are located on the east (Hakalau) and west (Puu Waawaa) sides of the island, with

breeding season primarily from October through March. After breeding, Nene assemble into family groups during flocking season, from April through September.

During flocking season birds make intra-island flights and congregate in summer flocking areas. Little is known about flocking movements and locations where birds spend the flocking season are poorly known as well. Nene are documented in the Mauna Loa Forest Reserve within ~1½ miles of the Mauna Loa LZs. Nene also use portions of the Kipuka Ainahou Nene Sanctuary within ~4 miles from the Mauna Loa LZs. Data indicate that Nene sometimes use the sanctuary area for roosting. The Pohakuloa Natural Resources Office has documented Nene at PTA in Training Area 21, ~3½-5 miles from the Mauna Loa LZs. Nene are known to use these PTA locations for occasional roosting, as well.

Although surveys did not detect Nene or Nene sign (droppings) at any LZ, it is reasonable to assume that geese have some undetermined presence in the sparsely vegetated habitat within the Mauna Loa LZ survey areas. Nene are known to exploit open pahoehoe lava flows that contain pukiawe (*Leptecophyla tameiameiae*), kukaenene (*Coprosma ernodeoides*), ohelo (*Vaccinium reticulatum*), and kupaoa (*Dubautia menziesii*), such as occur in the Mauna Loa LZ survey areas.

HAMET training is not expected to adversely affect Nene at any LZ. It is improbable that Nene occupy any sites within the Mauna Kea LZ survey areas. For the Mauna Loa LZ areas, near the Kipuka Ainahou sanctuary and PTA, geese are expected to be habituated to noise. Although some studies indicate geese are sensitive to helicopter noise (Ward et al., 1999), Nene are routinely found during flocking season in noisy habitats such as edges of highways (Saddle Road, Hawaii), airport runways (Kauai), and live-fire ranges (Pohakuloa). Noise levels from proposed HAMET operations are not expected to exceed 80 dB (A) in more than 0.2% of Kipuka Ainahou (Figure 2), and are expected to remain below 70 dB (A) in over 90% of Kipuka Ainahou during HAMET exercises. As an example of Nene habituation to noise, Nene at Pohakuloa are already exposed to noise from routine Combat Aviation Brigade and other helicopter exercises. In addition, under certain conditions, Nene within PTA and Keamuku Maneuver Area may be less than 50 ft from detonations, including grenades, mortars, artillery shells, tube-launched wire-guided missiles, bombs, fire suppression and training related helicopters, and loud voices (US FWS, 2008).

It is assumed that Nene near the LZs will depart the area as a helicopter approaches the LZ if noise levels become too high. This is based on guidance issued to the Army regarding Nene at Pohakuloa Range 01 by the US FWS: "…when noise is too loud or disruptive, the Nene will leave the premises or if they are habituated to the noise, then they are not losing any metabolic resources" (US FWS, 2008).

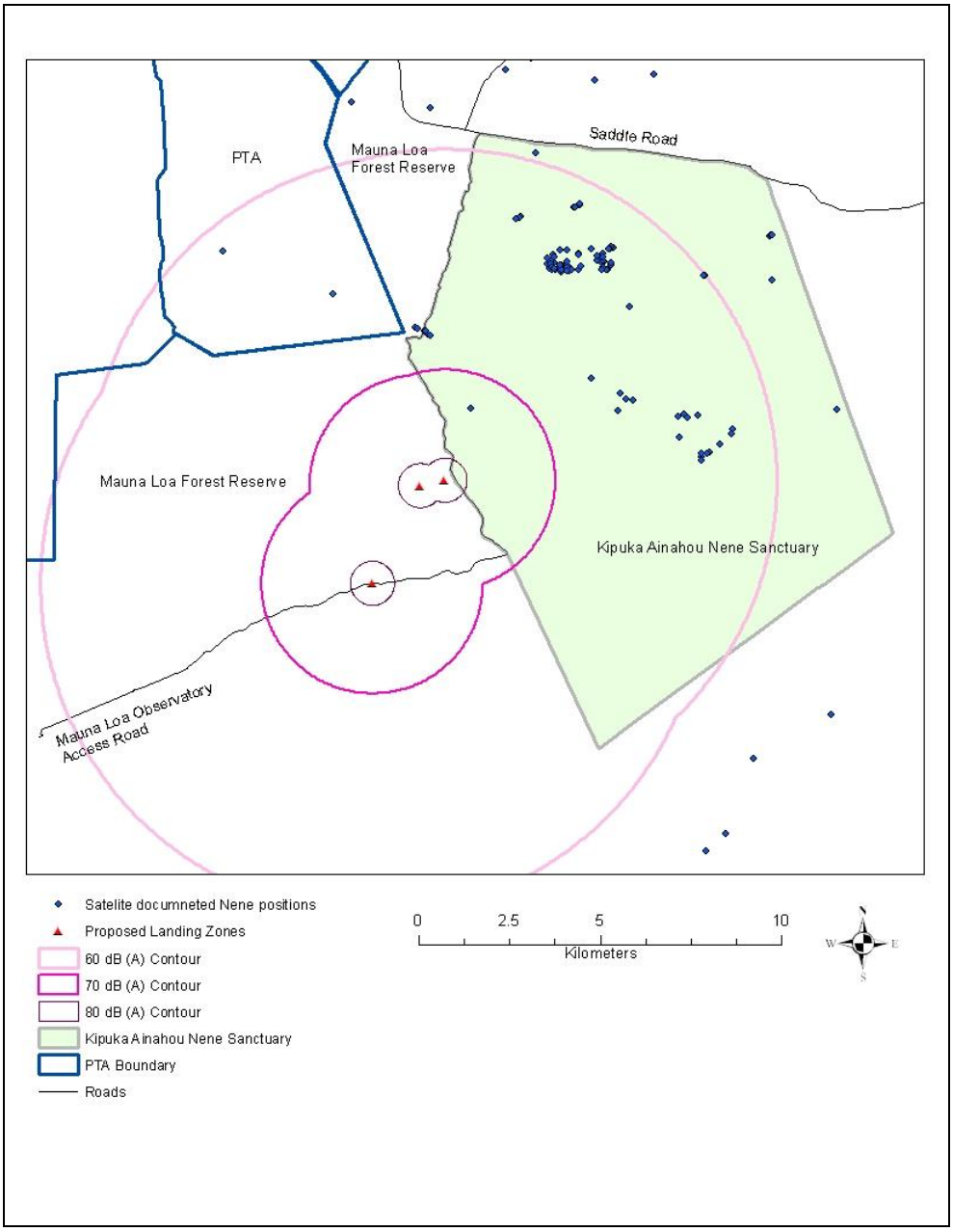

Figure 2. Documented Nene positions in the vicinity of Mauna Loa LZs.

Hawaiian Hawk, Io (*Buteo solitarius*) – Endangered (ESA)

The Hawaiian Hawk (Io) is widely distributed on Hawaii Island and is occasionally sighted on other Islands. Io breed solely on Hawaii Island and lay eggs from March to June which hatch from May to July (Clarkson and Laniawe, 2000). Young birds fledge from July to September. Io feed on rodents, insects, small birds, and some game birds.

These hawks use both native and altered habitats and are increasingly found within urban areas such as Hilo.

HAMET operations at the LZs on Mauna Loa and Mauna Kea are not likely to affect Io. No Io were seen during field surveys at any LZ. Sighting records indicate that there is a gap in the hawk's range, in the region between Mauna Kea and Mauna Loa, from Puu Huluhulu and PTA on the east, westward to Puu Waawaa (Banko, 1980b). This gap encompasses all proposed HAMET LZs. Io population density for LZs on Mauna Loa and Mauna Kea is therefore expected to be zero (Klavitter, 2000).

Palila (*Loxioides bailleui*) – Endangered (ESA)

Palila are currently found on the western and northwestern slopes of Mauna Kea in the mamane (*Chrysophylla sophora*) and naio (*Myoporum sandvicensis*) forests. Palila are specialized foragers, consuming the green seed pods of the mamane, which is the main component of their diet. Palila breed between March and August where the female usually lays two eggs (Banko et al., 2002). Both parents help tend the brood. Palila have been documented at treeline on Mauna Kea (~10,000 ft) and it is possible they will range across all elevations where mamane trees are found (Scott et al., 1984). A few trees grow in clusters above the main forest as treeline elevations are reached. The nearest mamane trees to the Mauna Kea LZs are more than 3000 ft distant. At 2000 ft from an LZ, expected sound level of a CH-47 is 77 dB (A).

No Palila were detected during surveys at the Mauna Kea LZs. Palila breed at lower elevations in the mamane dominated forest (Banko, et al., 2001) and are not expected to nest in the sparse trees at 3000 ft from the LZs. Also, if noise levels exceed comfort levels for Palila, it is assumed the birds will vacate the area temporarily and return after the disturbance. HAMET operations at Mauna Kea LZs are not expected to adversely affect Palila.

Akiapolaau (*Hemignathus munroi*) – Endangered (ESA)

The Akiapolaau is endemic to Hawaii Island and was once widely distributed on the island, but today is restricted to four fragmented populations in Kau, Hamakua, Kona, and Mauna Kea (Pratt et al., 2001). Akiapolaau consume wood boring insect by pecking open holes with its short stout lower bill and extracting the insect with its long upper beak. The birds also feed on Ohia (*Metrosideros polymorpha*) sap from holes they drill in the trees. The breeding season appears to be extended over the year and young have a long dependency period.

HAMET operations are not expected to affect Akiapolaau. No Akiapolaau were detected during surveys at any LZs. The Akiapolaau have been seen in the past five years on the western slope of Mauna Kea in the mamane forest, but the numbers of

birds appears to be low in the region of Mauna Kea proposed for training. Akiapolaau are not expected to forage or nest in the sparse trees at 3000 ft from the LZs. Also, if noise levels exceed comfort levels for Akiapolaau, it is assumed the birds will vacate the area temporarily and return after the disturbance.

For MBTA species, surveys were designed to determine the presence of MBTA listed species within the 2000 ft survey area for the proposed LZs. Transects spaced at 500 m were systematically placed to cover the maximum area inside the survey areas. Survey stations were located at 150 m intervals along each transect. The survey counting method is based on the US Fish and Wildlife Service Hawaiian Forest Bird Variable Circular-Plot (VCP) method (Reynolds et al., 1980; Scott et al., 1986). Using this method, one observer conducts counts at each station along a single transect. Each station is monitored for six minutes during a 4.5 hour sampling period (0630-1100). Every bird detected is recorded by detection type (aural, visual, or combined) and the horizontal distance from the station to the bird (Reynolds et al., 1980). Weather conditions, wind speed and cloud cover are also noted. Counts are not conducted on days when the weather is not within established guidelines.

For each Mauna Kea LZ a total of three transects with 54 stations were surveyed. Counts took place between 09:00 am and 11:15 am. Two House Finch were detected, one during and one after the count period. Both birds were not using the habitat, but only flying over the area. Because of the limitations on food resources on Mauna Kea in the vicinity of the LZs, it is assumed that the birds were transiting over the mountain between forested areas.

On Mauna Loa a total of five transects with 42 stations were surveyed. Counts took place between 08:00 am and 11:00 am. Results are summarized in Table 4.

Table 4. MBTA bird survey results

Common Name	Species	Quantity	Origin	Status
Apapane	*Himatione sanguinea*	32	Endemic	MBTA-Protected
Omao	*Myadestes obscurus*	40	Endemic	MBTA-Protected
House Finch	*Carpodacua mexicanus*	3	Introduced	MBTA-Protected

Of the 42 stations surveyed, Apapane, Oamo, and House Finch were present at 13 (31% occurrence), 25 (60% occurrence) and 3 (<1% occurrence) stations, respectively. The mean number of Apapane, Oamo and House Finch detected per station was 0.76,

0.95 and 0.70, respectively. Birds were detected more often at lower elevations within the survey areas for LZ 2 and LZ 3, than within the higher elevation survey area for LZ1.

Omao (*Myadestes obscurus*) – Protected (MBTA)

Omao, the most common of Hawaii's thrush species, is endemic to Hawaii Island, with an estimated population of 170,000 individuals (Scott et al., 1986). Populations are found in the Hamakua-Puna (eastern) and Kau (southern) regions of the island. A separate population exists in alpine scrub on Mauna Loa. Omao eat insects and fruits from many native plants. In the Mauna Loa scrub, Omao perch on elevated rocks ("sentry rocks") within their territories. Sentry rocks are recognizable by green growth as a result excreted wastes from perched birds. These sentry rocks are easy to spot and are good indicators of areas used by Omao. Omao likely maintain year-round core areas where they feed, roost and nest within larger home ranges (Wakelee and Fancy, 1999). In the alpine scrub, Omao will nest on the ground in lava formations and in lava tubes. Breeding activity occurs almost year-round, with a peak of nesting in April to July. The female incubates the eggs alone and spends on average ~40 minutes/hour on the nests with recesses averaging ~6½ minutes.

Mauna Loa survey results show Omao are widely distributed within the LZ survey areas. The majority of the birds were detected in LZ 2 and LZ 3 survey areas (36 out of 40 detections). Many sentry rocks are present within LZ 2 and LZ 3 survey areas, and indicate frequent use of the area by Omao.

HAMET operations are not expected to negatively impact the island-wide Omao population. Although comparisons between how species respond to noise cannot be directly related, many studies indicate incubating birds will tolerate high levels of noise before flushing from nests and quickly return once the noise has abated. Omao females routinely leave the nest to forage for up to 6.5 minutes at a time. HAMET operations are expected to last up to 10 minutes per helicopter landing. It is expected that females will return to nests once noise levels have abated.

HAMET operations could potentially impact individual and breeding pairs of Omao within the vicinity of an LZ if nests are located within a 325 ft radius of the LZ geographic coordinate. As discussed for the Botanical surveys (see Evans and Peshut MFR 30 March 2011) rotorwash from the largest aircraft (CH-47 Chinook) will first be felt on the ground when the aircraft is ~325 ft from the LZ center. At Mauna Loa LZ 3, potential Omao habitat exists within ~325 ft of the LZ where rotorwash could affect birds and nesting females. It is expected that non-nesting individuals within the survey area of the LZ will vacate the area temporarily during the disturbance and return after the operations.

There is no known information on the effects of helicopter rotorwash on nests, or nesting birds. For HAMET operations, rotorwash effects at near-ground level will be greatest at the center of LZs, and will diminish to ambient or near-ambient conditions at ~150 ft horizontally when helicopters are near touchdown or at take-off at the ground surface.

As mitigation, the Combat Aviation Brigade has indicated that the use of the LZ will be suspended for a period to be defined by the Natural Resources Office, if the presence of nesting Omao within 325 ft of LZ 3 is verified.

Although efforts to reduce or eliminate impacts to known Omao nesting sites will be conscientiously pursued by the Combat Aviation Brigade, there is always the potential for accidents. US congress has amended the MBTA to provide for the accidental death of MBTA species due to military training (Stump Act and Defense Reauthorization Act). Therefore, there is no regulatory liability in the unlikely event of the accidental death of nesting Omao at LZ 3.

Apapane (*Himatione sanguinea*) – Protected (MBTA)

Apapane are the most common of the Hawaiian Honeycreepers and are found on all major islands, but are rare on Lanai and Molokai. Apapane main food source is nectar from the Ohia (*Metrosideros polymorpha*) blossom, but this species also feeds on fruits and insects. The population on Hawaii Island is estimated at over one million (Scott et al., 1986). Breeding season is year-round with a nesting peak between February and June. Males feed females away from the nest requiring short incubation recesses. Nests inside lava tubes are documented and Apapane sometimes use old Omao nest material and nest sites in Hakalau National Wildlife Refuge (Fancy and Ralph, 1997).

Mauna Loa survey results indicate Apapane are well distributed within the surveyed areas for LZ 2 and LZ 3. No Apapane were recorded within the LZ 1 survey area. Apapane appear to be most associated with barren aa flows within the survey areas. During surveys, paired birds patrolled sections of aa while singing, indicating breeding territory defense. Apapane only defend territories during breeding season. Information regarding Apapane breeding in alpine scrub on Mauna Loa was not available.

HAMET operations are not expected to negatively impact the Apapane on Hawaii Island. However, HAMET operations could potentially impact individual Apapane within the surveyed areas. Although comparisons between how species respond to noise cannot be directly related, many studies indicate incubating birds will tolerate high levels of noise before flushing from nests and quickly return once the noise has abated. Apapane females routinely leave the nest during incubation to feed. Since HAMET operations are expected to last up to 10 minutes per helicopter landing, it is expected

that females will return to nests once noise levels have abated, with no negative consequences to nesting success.

At Mauna Loa LZ 2 and LZ 3, potential Apapane habitat exists within ~325 ft of the LZ where rotorwash could affect birds and nesting females. It is expected that non-nesting individuals within the buffer and ~325 ft of the LZs will vacate the area temporarily during the disturbance and return after the operations. For nesting birds, the situation for Apapane is similar to that for Omao (see above), and similar mitigation and considerations apply.

House Finch (*Carpodacua mexicanus*) – Protected (MBTA)

House Finch were first introduced to the Hawaiian Islands in the late 1800's and were common on all the major islands by the early 1900's. Fruit, seeds, buds and nectar comprise the House Finch's diet. Eggs are typically laid between late March and July and females may have more than one brood in a season (Hill, 1993). The birds nest in a variety of vegetation, natural features and man-made structures. Males only defend an area around the nest (to ~60 m) and pairs can nest in close proximity at preferred sites. House Finches are considered common, but population numbers for Hawaii are not known.

HAMET operations are not expected to negatively impact the House Finch population on Hawaii Island. Five individuals were detected during surveys among all the proposed LZs. The two individuals encountered on Mauna Kea were flying over the LZs and not using the habitat, as described previously. It is assumed that birds encountering aircraft and elevated noise levels will avoid the area temporarily. HAMET operations could potentially impact individual and breeding House Finch within the survey areas. Although comparisons between how species respond to noise cannot be directly related, many studies indicate that incubating birds will tolerate high levels of noise before flushing from nests and quickly return once the noise has abated. House Finch eggs are reportedly very cold tolerant and can tolerate low temperatures and hours-long gaps in incubation, and it is therefore expected that if individuals vacate the area temporarily during the disturbance, there will be no negative impacts to nesting success.

MBTA protected species that may occur in the LZ survey areas, but which were not detected during surveys, are discussed below.

Hawaii Amakihi (*Hemignathus virens*) – Protected (MBTA)

Hawaii Amakihi is the most commonly detected species at Pohakuloa Training Area and is also abundant throughout Hawaii Island with an estimated population of 870,000 (Scott et al., 1986). Hawaii Amakihi are small greenish-yellow birds feeding on fruits,

nectar and insects and are reported from low elevations in Puna (southeast) to high elevation alpine scrub. Hawaii Amakihi breed almost year-round with a breeding peak from March to May (Lindsey at al., 1998). Pairs establish home ranges and defend territories during breeding season. Territory size is dependent on vegetation type and reported sizes range from ~1-3 acres in open wooded edge habitat.

HAMET operations are not expected to negatively impact the Hawaii Amakihi population on Hawaii Island. Hawaii Amakihi were not detected during LZ buffer surveys, although this species is known to occupy habitat within 1 to 2 miles of the Mauna Kea and Mauna Loa LZs. Hawaii Amakihi are usually conspicuous when present in the environment. It is therefore unlikely that surveyors missed birds. It is probable Hawaii Amakihi use the habitat on Mauna Loa occasionally to forage. There are little or no food resources within the Mauna Kea survey areas, but birds may use the area as a flyway. If birds are present during HAMET operations, it is expected that individuals within the survey areas will vacate the area temporarily during high levels of noise and return after the noise has abated.

Northern Mockingbird (*Mimus ployglottus*) – Protected (MBTA)

Northern Mockingbirds were introduced to the Hawaiian Islands in 1920. On Hawaii Island, Northern Mockingbirds have been recorded from the western slope of Mauna Kea and in the Saddle region. Pairs defend year-round territories and breeding season is from March to August (Derrickson and Breitwisch, 1992). Northern Mockingbirds are omnivorous and consume insects, other invertebrates, fruits and occasionally small vertebrates.

HAMET operations are not expected to negatively impact the Northern Mockingbird population on Hawaii Island. Northern Mockingbirds were not detected during LZ surveys, although this species is known to occupy habitat within 1 to 2 miles of the Mauna Kea and Mauna Loa LZs. It is probable Northern Mockingbirds use the habitat on Mauna Loa occasionally to forage. There are little or no food resources within the Mauna Kea survey areas, but birds may use the area as a flyway. During HAMET operations, it is expected that individuals within the buffer will vacate the area temporarily during high levels of noise and return after the noise has abated.

Sky Lark (*Alauda arvensis*) – Protected (MBTA)

The Sky Lark was introduced to Hawaii from New Zealand populations in 1865 and is found on all the main islands except for Kauai. Sky Larks nest in open habitats with short grass cover and feed on insects. Sky Larks have been recorded on the western slope of Mauna Kea and from the Saddle region. Pairs maintain a territory during breeding season and may use the same territory for many years (Campbell et al.,

1997). Territory size is dependent on habitat, food resources and population density. In Hawaii, territorial singing begins in mid-October and ends by June.

HAMET operations are not expected to negatively impact the Sky Lark population on Hawaii Island. Sky Larks were not detected during LZ surveys, although this species is known to occupy habitat within 1 to 2 miles of the Mauna Kea and Mauna Loa LZs. Sky Larks are usually conspicuous between October and June when breeding; therefore it is unlikely that surveyors missed birds. Also, there is no breeding habitat for Sky Larks within the Mauna Loa and Mauna Kea LZ survey areas. It is probable that Sky Larks use the habitat on Mauna Loa occasionally to forage. There are little or no food resources within the Mauna Kea LZ survey areas, but birds may use the area as a flyway. During HAMET operations it is expected that individuals will vacate the area temporarily during high levels of noise and return after the noise has abated.

Pacific Golden-Plover (*Pluvialis fulva*) – Protected (MBTA)

The Pacific Golden-Plover is mostly a seasonal resident of the Hawaiian Islands and can be found during the winter months. Pacific Golden-Plovers from Hawaii return to Alaska to breed during summer months, but some individuals, mostly first-year birds, over-summer in Hawaii instead of migrating (Johnson and Connors, 2010). While in Hawaii, the Pacific Golden-Plover occupies a wide variety of habitats including mountain slopes up to 10,000 ft. Birds defend territories in Hawaii and may return annually to the same territory. Their diet consists of invertebrates, but they may also consume leaves and flowers.

HAMET operations are not likely to negatively impact Pacific Golden-Plover populations on Hawaii Island. Surveyors did not detect any individuals, but it is probable the birds use LZ areas occasionally. Pacific Golden-Plovers are commonly observed along Saddle Road (Highway 200) within a few miles of the LZ sites. It is assumed Pacific Golden-Plovers will vacate the area temporarily during HAMET operations if noise levels become too high, and then return once the noise has abated.

Barn Owl (*Tyto alba*) – Protected (MBTA)

Barn Owls are wide-spread and cosmopolitan, and are found throughout the Americas, Europe, and in parts of Africa and Asia (Marti et al., 2005). Barn Owls were first introduced to Hawaii in 1958 to control rodent populations in agricultural fields. Mice are the main prey of the Barn Owl in Hawaii, but these owls have been documented depredating seabirds as well (Pyle and Pyle, 2009). While Barn Owls prefer low elevation open habitats, birds are reported up to ~8200 ft on Hawaii Island and over 12,800 ft in South America. Barn Owls nest in cavities such as holes on the steep sides of cinder quarries in the Saddle region. Breeding courtship begins in January with eggs laid about a month later. Young usually fledge by mid-summer.

HAMET operations are not likely to impact the Barn Owl population on Hawaii Island. No Barn Owl nests were discovered within the expected rotorwash area (325 ft radius from LZ center) at either Mauna Loa or Mauna Kea, where noise level will be greatest (≥ 89 dB). Barn Owls have good hearing between 1-7 KHz and are able to discriminate well between frequencies within this range (Beason, 2004); therefore, loud, low frequency noise within this range may affect owls. In Oregon, nesting Mexican Spotted Owls (*Strix occidentalis lucida*) did not flush when helicopter (aircraft type unreported) noise levels were ≥ 92 dB (Delany et al., 1999). About 20% of Mexican Spotted Owls flushed when helicopters were ~200 ft distant. Although direct correlations between how Mexican Spotted Owls and Hawaiian Barn Owls respond to noise cannot be inferred, the study suggested that owl species may not be as sensitive to loud, low frequency noise, as once believed. Barn Owls may use the survey areas on Mauna Kea and Mauna Loa to forage, but it is assumed birds will temporarily vacate the area while noise levels are high and return to the area once noise levels have abated.

Hawaiian Short-Eared Owl (*Asio flammeus sandwichensis*) – Protected (MBTA)

The Hawaiian Short-Eared Owl, or Pueo, are active during the day and occupy a variety of forested habitats, but are most common in grassland habitat where rodents and the occasional bird are hunted. Pueo rely on acoustical clues to find prey, but can hunt by sight as well (Wiggins et al., 2006). No reliable population estimate is available, but the population reportedly cycles between high and low numbers, although the cause is not understood (Pyle and Pyle, 2009). Little information is available about the distribution of Pueo on Hawaii Island. Pueo are documented on the slopes of Mauna Kea and in the Saddle region. Pueo nest on the ground, usually in grass cover. Nests have been found year-round, but little is known about Pueo breeding ecology in Hawaii.

HAMET operations are not likely to impact the Pueo population on Hawaii Island. There is no suitable cover for Pueo to construct nests within the LZ survey areas for any of the LZs. Therefore, breeding within the LZ survey areas is highly unlikely. Pueo may use the LZ survey areas on Mauna Kea and Mauna Loa to forage, but it is assumed that birds will temporarily vacate the area while noise levels are high and return to the area once noise levels have abated.

Upland Game Birds – Not Protected

The public is permitted to hunt game birds in both the Mauna Kea and Mauna Loa Forest Reserves during an established season, which is usually between the months of November and January. Many species of game bird are present on Hawaii Island and several species are known to frequent high elevation scrub or barren habitats (Schwartz and Schwartz, 1966) (Table 5).

Table 5. Game bird species expected at high elevations in Mauna Kea and Mauna Loa Forest Reserves.

Species	Common Name
Callipepla californica	Califoinia Quail
Alectoris chukar	Chukar
Francolinus francolinus	Black Francolin
Francolinus pondicerianus	Gray Francolin
Francolinus erckelli	Erckel's Francolin
Phasianus colchicus	Ring-Necked Pheasant
Meleagris gallopavo	Wild Turkey

During surveys for all proposed LZs, no game birds were detected, but game bird droppings were present within all the survey areas, which indicates some level of habitat use. The sparse rocky habitat at the Mauna Kea LZ offers few food resources and may primarily be used as a movement corridor and/or roosting area by game birds. Although native shrubs offer food resources in the survey areas for the Mauna Loa LZs, the plants offer little cover and the area is probably used as a movement corridor and/or roosting area, only.

HAMET operations are not expected to negatively impact game bird populations on Hawaii Island. Due to the lack of cover for breeding at any of the LZ locations, it is unlikely training will impact bird reproduction. It is assumed that birds using the area for forage, movement, or roosting will temporarily vacate the area if noise levels become too high and return once the noise has abated.

Please contact Peter Peshut, 808-969-1966, peter.peshut@us.army.mil, for further discussions on HAMET operations and potential impacts to Hawaiian avifauna.

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Citation	Abstract	Species	Distance	DB	Response
Aubrey, F. and D. Hunsaker. 1997, Effects of fixed-wing military aircraft noise on California gnatcatcher reproduction. The Journal of the Acoustical Society of America 102, 3177.	To test the assumption that high levels of aircraft noise impede bird reproduction, noise analyzers were placed for 1 week in the nesting territory of each of 39 California gnatcatcher pairs on Naval Air Station Miramar. The 1-week average sound levels (7DL) recorded in those nesting territories were then related to the number of nest attempts; number of eggs laid; number of chicks hatched; number of chicks fledged; and number of eggs, chicks, and fledglings per nest attempt. Nest attempts and eggs laid have weak negative correlations (p=0.14 and 0.28) with 7DL. That is, the birds may tend to build fewer nests and lay fewer eggs in noisier areas, which is consistent with the common observation that bird nesting is more easily disturbed before eggs are laid than after. None of the other indicators is correlated with sound levels. Once a nest is established, with eggs in it, military aircraft noise has no detectable influence on reproductive performance. Gnatcatchers reproduced in places where 1 HL exceeds 80 dB for several hours every day. If fixed-wing aircraft noise impedes California gnatcatcher reproduction, it is overwhelmed by such factors as disturbance, predation, weather, edge effects, and differences in quality of habitat.	Gnatcatcher		1 HL exceeds 80 dB	Military aircraft noise has no detectable influence on reproductive performance.
Beason R.C. Through a bird's eye—exploring avian sensory perception [Internet]. Sandusky, OH, USDA Wildlife Services National Wildlife Research Center Ohio Field Station. [updated 2004 June, cited 2010 March]. Available from: http://www.aphis.usda.gov/wildlife_damage /nwrc/publications/03pubs/beason031.pdf	For too many birds their environment includes airfields and aircraft. Knowing avian sensory abilities, researchers can design experiments and develop new devices and techniques to deter birds from aircraft on and away from airfields. How birds perceive the world about them determines many choices, including foraging, predator avoidance, and flight. Most experiments to investigate the sensory abilities of birds have been developed and analyzed using only human sensory capabilities, which often differ markedly from those of birds. My objective is to review and synthesize what is known and what is unknown about avian sensory capabilities. Compared with humans, birds can distinguish more colors and detect ultraviolet and polarized light directly. Their range of auditory sensitivity is narrower than humans but some species can hear sounds at least as high pitched as humans. Their chemical	General			

Citation	Abstract	Species	Distance	DB	Response
	sensitivity is similar to humans in most cases but varies seasonally and can approach that of rodents. Avian vestibular sensitivity appears to be similar to other vertebrates but has received little investigation. There is a great deal we do not know about avian sensory perception that we need to know to make aircraft more obvious to birds and improve the effectiveness of dispersal techniques for individual species of birds.				
Black, B. B., M.W. Collopy, H.F. Percival, A.A Tiller and P.G. Bohall. 1984. Effects of low level military training flights on wading bird colonies in Florida. Florida Coop. Fish and Wild1. Research Unit, School of Forest Research and Conservation, University of Florida. Tech. Rept. No.7.	During 1983 and 1984 the effect of low level military training flights on the establishment, size and reproductive success of wading bird colonies was studied in Florida. Based on the indirect evidence of colony distributions and turnover rates in relation to military areas (training routes designated to 500 feet or less above ground level and military operations areas), there was no demonstrated effect of military activity on wading bird colony establishment or size on a statewide basis. Colony distributions were random with respect to military areas and turnover rates were within 2% when military and non-military areas were compared. Colony distributions and turnover rates, however, were related to the amount and type (estuarine or freshwater) of wetland, respectively. During two breeding seasons the behavioral responses and reproductive success of selected species were monitored in a non-habituated treatment colony (military overflights) and a control colony (no overflights). Breeding wading birds responded to F-16 overflights at 420 knots indicated airspeed, 82-84% maximum rpm, 500 feet above ground level and sound levels ranging from 55-100 dBA by exhibiting no response, looking up or changing position (usually to an alert posture): no productivity limiting responses were observed. High-nesting Great Egrets responded more than other species, nestling Great Egrets and Cattle Egrets responded significantly ($p < .05$) more intensely than adults of their respective species, and adults responded less during incubation and late chick-rearing than at other times. In addition, no differences in adult attendance, aggressive interactions or chick feeding rates	Wading Birds	500 AGL	55-100	Breeding wading birds responded to F-16 overflights at 420 knots indicated airspeed, 82-84% maximum rpm, 500 feet above ground level and sound levels ranging from 55-100 dBA by exhibiting no response, looking up or changing position (usually to an alert posture): no productivity limiting responses were observed.

Citation	Abstract	Species	Distance	DB	Response
	were observed to result from F-16 overflights. No evidence of habituation to overflights was noted. Humans entering the colony or airboats approaching the colony vicinity elicited the most severe responses (flushing and panic flights) observed at both sites. Since relatively little coastal military activity occurs at low levels (~500 ft) and only one Brown Pelican colony (5-6% of the breeding population) was located in such an area, the reproductive success of five, more "exposed" study species (Great Egrets, Snowy Egrets, Tricolored Herons, Little Blue Herons, Cattle Egrets) nesting in interior freshwater colonies was studied. Reproductive activity including such factors as nest success, nestling survival, nestling mortality, and nesting chronology was independent of F-16 overflights but related to ecological factors including colony location, colony characteristics and climatology. The responses to and effects of F-16 overflights, as reported here, should not be considered representative of military aircraft at lower altitudes or greater noise levels.				
Bowels, A.E. and S. Wisdom. 2005. The 60-dB rule for birds: An example of the application of a weighting function in environmental impact mitigation. The Journal of the Acoustical Society of America 118, 2018.	Over the last decade U.S. Fish and Wildlife Service managers in California have required millions of dollars in added expenditure for NEPA consultation, mitigation barriers, and project delays to reduce the effects of noise from construction activities on endangered passerine birds when the hourly A-weighted Leq is expected to exceed 60 dB. The rule was originally intended to prevent masking of species-typical songs of endangered birds such as the Coastal California Gnatcatcher. However, no research is available to demonstrate the effectiveness of the rule for any noise-related impact. Although A-weighting is probably a conservative estimator of bird exposure in the range from 125 Hz to 8 kHz, it may underestimate exposure at very low frequencies. Its utility as a weighting function has not been tested against other possible weighting procedures, such as use of the species-typical auditory threshold function. Additionally, where sources are intense but intermittent, Leq is unlikely to be a useful metric.	CA Gnatcatcher		60-dB rule	The rule was originally intended to prevent masking of species-typical songs of endangered birds such as the Coastal California Gnatcatcher. However, no research is available to demonstrate the effectiveness of the rule for any noise-related impact. These issues should receive more technical scrutiny before the 60-dB rule becomes entrenched in law.

Citation	Abstract	Species	Distance	DB	Response
	These issues should receive more technical scrutiny before the 60-dB rule becomes entrenched in law. It is in widespread use for NEPA consultations, and is already being extended to other species, including large mammals.				
Brown, A.L. 1990. Measuring the effects of aircraft in sea birds. Environmental Internacional 16, 587-592.	This paper reports on a procedure which exposes sea birds to acoustic stimuli simulating aircraft overflights, and is one of the first experiments to attempts to quantify the responses of birds in the wild to noise. The experiment, conducted in Australia's Great Barrier Reef, involved presentation of pre-recorded aircraft noise , which peak overflights levels of 65 dB(A) to 95 dB(A), to nesting sea bird colonies. Sea bird responses were videotaped and these tapes were subsequently analyzed by scoring the behavioral response of each bird in the colony. Results if a trial of this experimental procedure for one species, the Crested Tern (*Sterna bergii*), indicate that the maximum responses observed, preparing to fly or flying off, were restricted to exposures greater, than 85 dB (A). A scanning behavior involving head-turning was the minimum response and this, or a more intense response, was observed in nearly all birds at all levels of exposure. However an intermediate response, an alert behavior, demonstrated a strong positive relationship with increasing exposure. While the experiment had provided good control on simulated aircraft noise levels, preliminary observations of response of the colonies to balloon overflights suggests that visual stimulus is likely to be an important component of aircraft noise disturbance.	Sea birds, Crested Tern		65 dB(A) to 95 dB(A)	Results if a trial of this experimental procedure for one species, the Crested Tern (*Sterna bergii*), indicate that the maximum responses observed, preparing to fly or flying off, were restricted to exposures greater, than 85 dB(A).
Brown, B.T., C. Powels, W.A. Russell, G.D. Therres and J.J. Pottie. 1999. The influence of weapons-testing noise on bald eagle behavior. Journal of Raptor Research 33 227-232.	Minor/No Impacts We studied the influence of weapons-testing noise on bald eagle (*Haliaeetus leucocephalus*) behavior at the Aberdeen Proving Ground (APG); Maryland, in 1995. Our objectives were to document and compare eagle behavior at times with and without weapons-testing noise, determine if the frequency of behavior after noise increased with increasing sound levels and compare nest success and productivity on APG with that of adjacent areas of Maryland. Most roosting (72.7%) and nesting (92.7%) eagles showed no	Bald Eagle	.5-4KM	110 dBP (unweighted peak)	non activity behaviors when noise levels were < 110 dBP (unweighted Peak) and > 110 dBP for either roosting or nesting eagles.

Citation	Abstract	Species	Distance	DB	Response
	activity (i.e., perched motionless) in the 2-sec interval following weapons-testing noise. The most frequent activity following noise was a head turn, exhibited by 18.2% of roosting and 0.7% of nesting eagles; other eagle activities following noise (e.g., body movement, vocalization and flight) were rare at both roosts (9.1%) and nests (6.6%). Frequency of activity after noise differed between adults and juveniles at nests, but did not differ between adults and immatures at roosts. Activity after noise occurred significantly more in roosting than nesting eagles. For roosting eagles, frequency of activity after noise was similar to activity at times without noise. Frequency of no activity versus activity after noise did not vary at sound intensity levels >or= 110 and < 110 dBP for either nesting or roosting eagles. Nest success and productivity on APG did not differ from nest success and productivity in adjacent counties of Maryland from 1990-95, suggesting that weapons-testing noise did not influence eagle reproduction at the population level.				
Bunnell, F.L., D. Dunbar, L. Koza and G. Ryder. 1981. Colonial Waterbirds 4, 2-11.	Acknowledging the declining status of the single colony, the White Pelican was designated as "Endangered" within the British Columbia Endangered Species Act in March 1980. During the eight years for which we have detailed records the major factors contributing to the decline of the pelican appeared to be disturbance by humans (low flying aircraft) and coyote predation. Both factors can dramatically reduce survivorship of young and overall productivity of the colony. This paper discusses those factors and examines their potential impact over longer periods by using a simple simulation model.	White Pelican			Disturbance, whether natural or human induced, dramatically alters these measures of productivity or survivorship. Effects of low-flying aircraft appear less disturbing to other colonial waterbird species than to White Pelicans.
Burger, J. 1983. Jet Aircraft and Bird Strikes: Why More Birds Are Being Hit. Environmental Pollution (Series A) 30,143-152.	The noise levels of departing and landing aircraft were examined as a function of type of aircraft at J.F. Kennedy International Airport in New York. In general, the wide-bodied aircraft (Boeing 747, L1011, DC10) were significantly quieter than the old-type, narrow-bodied aircraft (Boeing 707, 727). Noise levels varied when approaching planes were different distances from the test site. Noise levels did not rise significantly higher than pre-departure levels	General	600 m	≤85 dB (scale not reported)	Bird species are present at run ways where ambient noise levels averages 86.5 and 66 dB. When planes take off noise levels climb to over 100 dB.

Citation	Abstract	Species	Distance	DB	Response
	until the planes were 600m and 800 m from the test site, and the planes traversed this distance in an averages of 9-14 s. For landing planes, the narrow-bodies planes were significantly louder than the wide-bodied planes at touchdown, only 600 m from the test site. Wide-bodied planes had significantly more bird strikes than the narrow-bodied aircraft. These results indicate that birds have less warning of an approaching wide-bodied aircraft than they have for a narrow-bodied aircraft. The bird's behavior of facing and flying into the wind (the same direction as the airplane is moving) increases the perception and decreases the flight speed of the bird, and increases the risk of a bird strike (particularly for the wide-bodied aircraft).				No analysis of bird behavior response to the noise.
Conomy, J.T., J. Collazo, and W.J. Fleming. 1993. Effects of aircraft noise on time-activity budgets of wintering black ducks. Acoustic Society of America, 125th Meeting, Ottawa.	The primary goal of this study was to determine if the time-activity budget (TAB) of wintering black ducks (*Anas rubripes*) was significantly altered by military aircraft noise at the U. S. Marine Corps target range in Piney Island, North Carolina. Sound levels were measured concurrently with behavioral observations. Over a sampling period of 81 days, exceedances >80 dB occurred on 289 occasions, the mean duration of exceedances was 5.09 s, and the mean sound pressure was 85.7 dB. Black ducks spent between 0.2% and 0.5% of their time reacting to aircraft. Correspondingly, the energetic costs of these reactions were low. TABs of black ducks in the high noise environment of Piney Island were within the expected range of those in low noise environments based on published literature. In a follow-up study, captive black ducks were subjected to simulated jet noise at levels approximately those recorded in the field. Measured levels of reactions to noise stimuli indicated that ducks habituated within 1 day. These results suggest that low reaction levels recorded in the field reflect the species' habituation capabilities to some kinds of disturbance. [Work supported by USMC and USAF.]	Black Duck	Not reported	>80dB (scale not reported)	Energetic costs of responding to aircraft noise were low. Results suggest that low reaction levels recorded in the field reflect the species' habituation capabilities to some kinds of disturbance.

Citation	Abstract	Species	Distance	DB	Response
Conomy, J.T., J.A. Collazo, J.A. Dubovsky and W.J. Fleming. 1998. Dabbling Duck Behavior and Aircraft Activity in Coastal North Carolina. Journal of Wildlife Management 62, 1127-1134.	Requests to increase military aircraft activity in some training facilities in the United States have prompted the need to determine if waterfowl and other wildlife are adversely affected by aircraft disturbance. We quantified behavioral responses of wintering American black ducks (*Anas rubripes*), American wigeon (*A. americana*), gadwall (*A. strepera*), and American green-winged teal (*A. crecca carolinensis*) exposed to low-level flying military aircrafts at Piney and Cedar islands, North Carolina, in 1991 and 1992. Waterfowl spent ltoreq1.4% of their time responding to aircraft, which included flying, swimming, and alert behaviors. Mean duration of responses by species ranged from 10 to 40 sec. Costs to each species were deemed low because disruptions represented a low percentage of their time-activity budgets, only a small proportion of birds reacted to disturbance (13/672; 2%), and the likelihood of resuming the activity disrupted by an aircraft disturbance event was high (64%). Recorded levels of aircraft disturbance (i.e.,x = 85.1 dBA) were not adversely affecting the time-activity budgets of selected waterfowl species wintering at Piney and Cedar islands	Dabbling Duck		85 dB (A)	Recorded levels of aircraft disturbance (N=311) (i.e., x = 85.1 dBA) were not adversely affecting the time-activity budgets of selected waterfowl species wintering at Piney and Cedar islands.
Conomy, J.T., J.A. Collazo, J.A. Dubovsky and W.J. Fleming.1998. Do Black Ducks and Wood Ducks Habituate to Aircraft Disturbance? Journal of Wildlife Management 62, 1135-1142.	Requests to increase military aircraft activity in some training facilities in the United States have raised the need to determine if waterfowl and other wildlife are adversely affected by aircraft disturbance. We hypothesized that habituation was a possible proximate factor influencing the low proportion of free-ranging ducks reacting to military aircraft activities in a training range in coastal North Carolina during winters 1991 and 1992. To test this hypothesis, we subjected captive, wild-strain American black ducks (*Anas rubripes*) and wood ducks (*Aix sponsa*) to actual and simulated activities of jet aircraft. In the first experiment, we placed black ducks in an enclosure near the center of aircraft activities on Piney Island, a military aircraft target range in coastal North Carolina. The proportion of times black ducks reacted (e.g., alert posture, fleeing response) to visual and auditory aircraft activity decreased from 38 to 6% during the first 17 days of confinement. Response rates remained	Black and Wood Ducks			With continued exposure of aircraft noise, black ducks may become habituated. However, wood ducks did not exhibit the same pattern of response, suggesting that the ability of waterfowl to habituate to aircraft noise may be species specific.

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	stable at 5.8% thereafter. In the second experiment, black ducks and wood ducks were exposed to 6 different recordings of jet noise. The proportion of times black ducks reacted to noise decreased (P < 0.05) from first day of exposure (25%) to last (i.e., day 4; 8%). Except for a 2% difference in comfort, we detected no differences (P > 0.05) in time-activity budgets of black ducks between pre-exposure to noise and 24 hr after first exposure. Unlike black ducks, wood duck responses to jet noise did riot decrease uniformly among experimental groups following initial exposure to noise (P = 0.01). We conclude that initial exposure to aircraft noise elicits behavioral responses from black ducks and wood ducks. With continued exposure of aircraft noise, black ducks may become habituated. However, wood ducks did not exhibit the same pattern of response, suggesting that the ability of waterfowl to habituate to aircraft noise may be species specific.				
Delaney D.K., L.L. Pater, T.J. Hayden, L.L. Swindell, T.A. Beaty, L.D. Carlile and W.E. Spadgenske. 2000. Assessment of training noise impacts on the red-cockaded woodpecker: 1999 results. U.S. Army Corps of Engineers, Engineer Research and Development Center.	Because military noise management has traditionally focused on minimizing human annoyance, loud training activities have often been relocated to sparsely populated areas where wildlife species reside. This has led to increased conflicts between training activity and conservation of threatened and endangered species. Increasing importance has been placed on determining how noise affects these species. This study to determine the effects of certain kinds of training noise on the endangered Red-cockaded Woodpecker (RCW). This research shows that the basic technical approach to data gathering and analysis is appropriate and effective. Preliminary data suggest that measured levels of military training noise did not affect RCW nesting success and productivity. The RCW flushed infrequently and returned to their nests quickly.	Red-cockaded Woodpecker			Preliminary data suggest that measured levels of military training noise did not affect RCW nesting success and productivity. The RCW flushed infrequently and returned to their nests quickly.
Delaney, D.K., L.L. Pater, R.H. Melton, B.A. MacAllister, R.J. Dooling, R. Lohr, B.F. Brittan-Powe, L.L. Swindell, T.A. Beaty, L.D. Carlile, and E.W. Spadgenske. 2002. SERDP Project CS-1083.	Assessed the effects of military training noise on red-cockaded woodpeckers. Disturbed and undisturbed nest sites did not differ significantly in the number of eggs, number of nestlings, or number of young fledged. 7 of 25 nesting attempts at disturbed sites were second attempts; none of the 16 nesting attempts at	Red-cockaded Woodpecker, Raptors, Gallinaceous	30 m 30-60 m	102 dB 105 dB (A) 95 dB (A)	83 helicopter passes during 45 data sessions at 19 RCW clusters failed to elicit a flush response, at distances as low as 30m and sound

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	undisturbed sites were second attempts (n. s., p>.05). Noise recorded in cavities was up to 15 dB louder (at 250 Hz) than levels recorded at the base of the same tree. No flushes at SEL noise levels below 87 dBA or beyond 1800m for large caliber noise. No flush when small arms were >1000m or SEL less than 63 dBA.83 helicopter passes during 45 data sessions at 19 RCW clusters failed to elicit a flush response, at distances as low as 30m and sound levels of 102 dB unweighted. Studies that have examined the effects of aircraft activity on nesting birds (e.g., Platt 1977; Windsor 1977; Ellis 1981; Anderson et al. 1989; Delaney et al. 1999) have often noted a slight but insignificant decrease in nesting success and productivity for disturbed versus undisturbed nests. Anderson et al. (1989) reported that two of 29 Red-tailed Hawk nests were abandoned after being flushed by helicopter flights, compared with zero of 12 control nests. Ellis et al. (1991) found only one of 19 Prairie Falcon (*Falco mexicanus*) nests were abandoned when exposed to frequent low-altitude jet flights during the nesting season (no control sites used). Platt (1977) reported similar rates with only one of 11 Gyrfalcon (*F. rusticolus*) nests failing (reportedly due to snow damage), compared with zero of 12 control nests. Of the six Peregrine Falcon (*F. peregrinus*) nests exposed to helicopter flights, only one was abandoned (also apparently due to inclement weather) compared with zero of three control sites (Windsor 1977). Snyder et al. (1978) reported that Snail Kites (*Rostrhamus sociabilis*) did not flush even when noise levels were up to 105 decibels, A-weighted (dBA) from commercial jet traffic. This result was qualified by the fact that test birds were living near airports and may have habituated to the noise. Edwards et al. (1979) found a dose-response relationship for flush responses of several species of gallinaceous birds when approach distances were between 30 and 60 m and noise levels approximated 95 dBA. Brown et al. (1999) reported no difference in the frequency of Bald Eagle activity and non activity behaviors when noise levels were < 110 dBP (unweighted Peak) and > 110 dBP for either roosting or				levels of 102 dB unweighted Snyder et al. (1978) reported that Snail Kites (Rostrhamus sociabilis) did not flush even when noise levels were up to 105 decibels, A-weighted (dBA) from commercial jet traffic. Edwards et al. (1979) found a dose-response relationship for flush responses of several species of gallinaceous birds when approach distances were between 30 and 60 m and noise levels approximated 95 dBA.

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	nesting eagles. Delaney et al. (1999) reported that Mexican Spotted Owls did not flush during the nesting season when the Sound Exposure Level (SEL) for helicopters was ≤ 102 owl-weighted, dBO (≤ 92 dBA) and the Equivalent Average Sound Level (LEQ) for chain saws was ≤ 59 dBO (≤ 46 dBA). Delaney et al. (2000, 2001) and Pater et al. (1999) developed noise response thresholds for RCWs based on a number of military noise sources. Their preliminary results show that woodpeckers do not flush during the nesting season when the SEL for artillery simulators are < 89 dB, unweighted (< 84 dBA); .50-caliber blank fire was < 82 dB, unweighted (< 72 dBA); military helicopter overflights were < 102 dB, unweighted (< 85 dBA); small-caliber live fire events were < 79 dB, un-weighted (< 77 dBA); large-caliber live fire events were < 103 dB, unweighted (< 85 dBA); and grenade simulators were < 91 dB, unweighted (< 84 dBA).				
Delaney, D.K., T.G. Grubb, P. Beier, L.L. Pater and M.H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63, 60-76.	Military helicopter training over the Lincoln National Forest (LNF) in south central New Mexico has been severely limited to protect nesting Mexican spotted owls (*Strix occidentalis lucida*). To evaluate nesting and nonnesting spotted owl responses to helicopter noise, we measured flush frequency, flush distance. alert behavior, response duration, prey delivery rates, female trips from the nest, and nest attentiveness during manipulated and nonmanipulated periods, 1995-96. Chain saws were included in our manipulations to increase experimental options and to facilitate comparative results. We analyzed stimulus events by measuring noise levels as unweighted one-third-octave hand levels, applying frequency weighting to the resultant spectra, and calculating the sound exposure level for total sound energy (SEL) and the 0.5-sec equivalent maximum energy level (LEQ max 0.5-sec) for helicopters, and the 10-sec equivalent average energy, level (LEQ avg. 10-sec) for chain saws. An owl-weighting (dBO) curve was estimated to emphasize the middle frequency range where strigiform owls have the highest hearing sensitivity. Manipulated and nonmanipulated nest sites did not differ in	Mexican Spotted Owl	105 m	105 dBO (Owl)	We recorded no spotted owl flushes when noise stimuli were >105 m away. Spotted owls returned to predisturbance behavior within 10-15 min after a stimulus event.

Citation	Abstract	Species	Distance	DB	Response
	reproductive success (P = 0.59) or the number of young fledged (P = 0.12). As stimulus distance decreased, spotted owl flush frequency increased, regardless of stimulus type or season. We recorded no spotted owl flushes when noise stimuli were >105 m away. Spotted owls returned to predisturbance behavior within 10-15 min after a stimulus event. All adult flushes during the nesting season occurred after juveniles had left the nest. Spotted owl flush rates in response to helicopters did not differ between nonnesting (13.3%) and nesting seasons (13.6%; P = 0.34). Spotted owls did not flush when the SEL noise level for helicopters was ltoreq102 dBO (92 dBA) and the LEQ level for chain saws was ltoreq59 dBO (46 dBA). Chain saws were more disturbing to spotted owls than helicopter flights at comparable distances. Our data indicate a 105-m buffer zone for helicopter overflights on the LNF would minimize spotted owl flush response and any potential effects on nesting activity.				
Dooling R.J., A. Lauer, M. Dent and I. Noirot. 2005. The problem of frequency weighting functions and standards for birds. The Journal of the Acoustical Society of America 118, 2018.	Frequency weighting functions in humans are widely used as a single-figure guess to assess noise problems and aid in making decisions with regard to noise limitations when no other data exist. However, this use of frequency weightings invariably results in a loss of precision in assessing the likelihood of a sound to produce hearing damage or sound annoyance. There is a growing interest in developing frequency weighting functions in animals presumably to assist in judging the risk of hearing damage, interference with acoustic communication, or habitat suitability. Laboratory studies reveal many parallels between humans and animals on a variety of psychoacoustic measures, such as equal loudness contours. However, differences between humans and animals on specific tests argue against using standards developed for humans to gauge the effect of noise on animals. Here we review data which show this same problem exists among birds. That is, the differences in the effects of noise among bird species can be as large as the differences between humans and birds. These results suggest that whereas frequency weighting functions and acoustic standards for a specific	General Hearing			These results suggest that whereas frequency weighting functions and acoustic standards for a specific species might be useful, generalizing across species is likely not practical.

Citation	Abstract	Species	Distance	DB	Response
	species might be useful, generalizing across species is likely not practical.				
Dooling R.J., B.M. Ryals and K. Manabe. 1997. Recovery of hearing and vocal behavior after hair-cell regeneration. Psychology 94, 14206-14210.	Postmitotic hair-cell regeneration in the inner ear of birds provides an opportunity to study the effect of renewed auditory input on auditory perception, vocal production, and vocal learning in a vertebrate. We used behavioral conditioning to test both perception and vocal production in a small Australian parrot, the budgerigar. Results show that both auditory perception and vocal production are disrupted when hair cells are damaged or lost but that these behaviors return to near normal over time. Precision in vocal production completely recovers well before recovery of full auditory function. These results may have particular relevance for understanding the relation between hearing loss and human speech production especially where there is consideration of an auditory prosthetic device. The present results show, at least for a bird, that even limited recovery of auditory input soon after deafening can support full recovery of vocal precision.	General hearing			The present results show, at least for a bird, that even limited recovery of auditory input soon after deafening can support full recovery of vocal precision.
Dooling, R.J. 2002. Avian Hearing and the Avoidance of Wind Turbines. National Renewable Energy Lab. Technical Report NREL/TP-500-30844.	This report provides a complete summary of what is known about basic hearing capabilities in birds in relation to the characteristics of noise generated by wind turbines. It is a review of existing data on bird hearing with some preliminary estimates of environmental noise and wind turbine noise at Altamont Pass, California, in the summer of 1999. It is intended as a resource in future discussions of the role that hearing might play in bird avoidance of turbines. The main body of this report describes hearing measurement in birds, the effects of noise on hearing, and the relationship between avian hearing and the general noise levels around wind turbines. The main body is followed by four appendices. Appendix A is a table organized by species which provides a comprehensive bibliography of the literature on hearing in the quiet (audiograms) in birds, followed by Appendix B which provides plots of the audiograms from 49 species of birds that have been tested to date. Similarly, a bibliography of the literature on how birds hear in noise is given in a table in Appendix C, with corresponding	General Hearing			The main body of this report describes hearing measurement in birds, the effects of noise on hearing, and the relationship between avian hearing and the general noise levels around wind turbines. When hearing is defined as the softest sound that can be heard at different frequencies, birds on average hear less well than many mammals, including humans. Birds hear best between about 1 and 5 kHz.

Citation	Abstract	Species	Distance	DB	Response
	plots of masked auditory thresholds in Appendix D. There are a number of long-standing myths about what birds can or cannot hear. One myth is that birds hear better at high frequencies than do humans or other mammals. Another myth is that birds have exceptionally acute hearing. A considerable amount of work over the past 50 years has repeatedly shown that neither of these notions is true. When hearing is defined as the softest sound that can be heard at different frequencies, birds on average hear less well than many mammals, including humans. Birds hear best between about 1 and 5 kHz. Acoustic deterrents or “scarecrow” devices are not generally effective because birds habituate to them and eventually ignore them completely. Devices that purport to use sound frequencies outside the hearing range of humans are most certainly inaudible to birds as well because birds have a narrower range of hearing than humans do. A review of the literature on how well birds can hear in noisy (windy) conditions suggests that birds cannot hear the noise from wind turbine blades as well as humans can. In practical terms, a human with normal hearing can probably hear a wind turbine blade twice as far away as can the average bird.				
Dooling, R.J., M.L Dent, M.R. Leek and O. Gleich. 2001. Masking by harmonic complexes in birds: behavioral thresholds and cochlear responses. Hearing Research 152 (2001), 159-172.	Thresholds for pure tones embedded in harmonic complexes were measured behaviorally and physiologically for three species of birds, and physiologically in gerbils. The harmonic maskers were generated using the Schroeder-phase algorithm, characterized by monotonically increasing or decreasing phase across frequency. Previous work has shown that these stimuli produce large differences in masking in humans but not budgerigars. In this study, we show that for two additional species of birds, the patterns of masking were similar to those shown for budgerigars, with masking differing only slightly for the two Schroeder-phase waveforms, and in the opposite direction from that demonstrated in humans. Amounts of masking among species corresponded qualitatively to differences in their	General Masking			The patterns of masking were similar to those shown for budgerigars, with masking differing only slightly for the two Schroeder-phase waveforms, and in the opposite direction from that demonstrated in humans.

Citation	Abstract	Species	Distance	DB	Response
	critical ratios. Evoked potential measurements in birds and gerbils indicated responses that were consistent with the behaviorally measured thresholds in birds and humans. Results are interpreted in light of differences in frequency selectivity and cochlear temporal processing across species.				
Goudie, R.I. 2006. Multivariate behavioural response of harlequin ducks to aircraft disturbance in Labrador. Environmental Conservation 33, 28-35.	The effects of low-level aircraft over-flights on behaviour of harlequin ducks (*Histrionicus histrionicus*) breeding in central Labrador were quantified during 2000–2002. The Canadian Department of National Defense supports a low-level training programme in the 130 000 km2 Military Training Area of Labrador involving military jets. The Institute for Environmental Monitoring and Research (IEMR) undertakes scientific research into environmental impacts of low-level military jet over-flights. A suite of 17 behavioural categories of paired male and female harlequin ducks was modeled, and a canonical variable representing alert behaviour, inactivity on the water and decreased inactivity out of water in response to over-flights represented 73.1% of the variance in the data cluster and provided marked separation of disturbed and undisturbed groups. Behavioural responses of harlequin ducks to military jets were 23 times stronger than their responses to floatplanes, helicopters and military cargo planes, and the significant interaction of aircraft type and noise indicated that noise may be the primary stressor affecting behaviour. A quadratic response of the canonical variable to noise generated from aircraft during standardized 30-minute observation periods was defined. The multivariate analyses were more robust because they indicated covariance in behavioural categories associated with disturbance that was not originally detected in univariate analyses, suggesting the importance of integrating behaviours other than overt responses. The significant effects of military jet over-flights on harlequin duck behaviour emphasize the need to evaluate potential population consequences of aircraft disturbance.	Harlequin Duck			Behavioural responses of harlequin ducks to military jets were 23 times stronger than their responses to floatplanes, helicopters and military cargo planes, and the significant interaction of aircraft type and noise indicated that noise may be the primary stressor affecting behaviour.

Citation	Abstract	Species	Distance	DB	Response
Goudie, R.I. and I.L. Jones. 2004. Dose-response relationships of harlequin duck behavior to noise from low-level military jet over-flights in central Labrador. Environmental Conservation 31,289-298.	Concern for the lack of field studies on the effects of low-level military jet over-flights on wildlife resulted in directed research in the Military Training Area of Labrador, 1999--2002. At Fig River, a tributary of the Lower Churchill River, a before-after-control-impact (BACI) study design quantified effects of aircraft overflights on behavior of individual harlequin ducks (*Histrionicus histrionicus*) in the 130 000km2 Military Training Area of central Labrador. Noise generated from low-level passes (30--100m above ground level) by military jets was sudden in onset and high in amplitude (>100 dBA), substantially above background sound levels both at Fig Lake outlet (40--50 dBA) and rapid sections of Fig River (60--70 dBA). Harlequin ducks reacted to noise from military jets with alert behavior, showing a positive dose-response that especially intensified when noise exceeded 80 dBA. Residual effects, in other words, deviations from normal behavior patterns after initial responses, were decreased courtship behavior for up to 1.5 h after, and increased agonistic behavior for up to 2 h after military jet over-flights. Direct behavioral responses to military jet over-flights were of short duration (generally <1 min), and were unlikely to affect critical behaviors such as feeding and resting in the overall time-activity budgets of breeding pairs. However, the presence of residual effects on behavior implied whole-body stress responses that were potentially more serious; these require further study because they are potentially more detrimental than immediate responses, and may not be detected in studies that focus on readily observed overt responses. A dose-response curve relating particular behaviors of harlequin ducks to associated noise of over-flights could be a valuable conservation tool for the research and mitigation of environmental impacts of aircraft and other noise.	Harlequin Ducks	30-100 m (AGL)	>100 dB (A)	Harlequin ducks reacted to noise from military jets with alert behavior, showing a positive dose-response that especially intensified when noise exceeded 80 dBA. Direct behavioral responses to military jet over-flights were of short duration (generally <1 min), and were unlikely to affect critical behaviours such as feeding and resting in the overall time-activity budgets of breeding pairs.
Grubb, T.G., and W.W. Bowerman. 1997. Variations in breeding bald eagle response to jets, light planes, and helicopters. Journal of Raptor Research 31 213-222.	We analyzed 3122 observations of military jets, light planes and helicopters for three levels of response (none, alert, flight) by breeding Bald Eagles (*Haliaeetusl eucocephaluast*) 13 occupied nests in Arizona and six in Michigan, 1983-85 and 1989-90, respectively. Helicopters	Bald Eagles	600 meters		Distance from eagle to aircraft, duration of overflight and number of aircraft and/or passes were the most important

Citation	Abstract	Species	Distance	DB	Response
	elicited the greatest frequency of response (47%), followed by jets (31%) and light planes (26%). Frequency of response (23-61%) and frequency of flight (2-13%) both increased through the nesting season from February to June. Distance from eagle to aircraft, duration of overflight and number of aircraft and/or passes were the most important characteristics influencing eagle responses to pooled and individual aircraft types. Classification tree (CART) models for individual aircraft types provide dichotomous keys of distance and secondary variables affecting associated response rates, and should facilitate evaluating aircraft-Specific impacts. Our analyses indicate a categorical exclusion of aircraft within 600 m of nest sites would limit Bald Eagle response frequency to 19%.				characteristics influencing eagle responses to pooled and individual aircraft types. Our analyses indicate a categorical exclusion of aircraft within 600 m of nest sites would limit Bald Eagle response frequency to 19%.
Harms, C.A., W. J. Fleming and M.K. Stoskopf. 1997, A technique for dorsal subcutaneous implantation of heart rate biotelemetry transmitters in black ducks: Application in an aircraft noise response study. Condor 99, 231-237.	A technique for heart rate biotelemetry transmitter implantation was developed to monitor heart rate fluctuations of Black Ducks (*Anas rubripes*) in response to simulated aircraft noise in a large outdoor enclosure. A dorsal subcutaneous approach, with subcutaneous tunneling of lead wires, was employed for placement of the 32 g transmitters. A base-apex lead configuration, with leads anchored at the dorsal cervico-thoracic junction and the caudal keel, yielded the maximal ECG wave-form deflection for triggering the transmitter. Heart rates of six Black Ducks (three in each of two separate trials) were monitored for 3 days pre-noise to establish a baseline, and then for 4 days of simulated aircraft noise. The noise stimulus replicated an FB-111 military jet, and was played 48 times per day at a peak volume of 110 dB. Daily mean heart rates, used as indicators of metabolic rates, did not increase in response to noise. Recognizable acute heart rate increases corresponding with a noise event occurred with increased frequency during the first day of noise presentation, but on subsequent days the responses did not differ significantly from baseline. Acute heart rate responses to aircraft noise diminished rapidly, indicating the ability of Black Ducks to habituate to the auditory component of low altitude aircraft overflights.	Black Duck		110 dB	Acute heart rate responses to aircraft noise diminished rapidly, indicating the ability of Black Ducks to habituate to the auditory component of low altitude aircraft overflights.

Citation	Abstract	Species	Distance	DB	Response
Hunsaker, D., J. Rice, and J. Kern. 2007. The effects of helicopter noise on the reproductive success of the coastal California gnatcatcher. Journal of Acoustic Society of America 122, 3058.	Our laboratory conducted a five-year study on the potential effects of helicopter noise on the reproductive success of the coastal California gnatcatcher (*Polioptila californica californica)* on Marine Corps Air Station Miramar (MCAS Miramar) in Southern California. Seven-hundred twenty-one nests were monitored for reproductive success, predation, noise levels, and habitat quality. An array of Larson-Davis sound level meters was used to monitor habitat on MCAS Miramar for a total of 6,176 days during 620 runs at 328 locations. Most sites were exposed to noise in excess of 60 dB(A) SPL for less than 5% of the monitoring period, but some nests experienced levels in excess of 70 dB(A) for more than 20% of the time. Statistical models of nest success, nest site selection, and number of fledges per pair showed that the factors best predicting reproductive success were measures of suitable nesting habitat, not noise levels. Helicopter and other noise sources did not affect the reproductive success of gnatcatchers. (Supported by the Marine Corps Air Bases Western Area and the Naval Facilities Engineering Command, SW.)	CA Gnatcatcher		60-70 dB(A)	Statistical models of nest success, nest site selection, and number of fledges per pair showed that the factors best predicting reproductive success were measures of suitable nesting habitat, not noise levels. Helicopter and other noise sources did not affect the reproductive success of gnatcatchers.
Larkin, L.P., L.L. Pater and D.J. Tazik. 1996. Effects of Military Noise on Wildlife: A Literature Review. USACERL Technical Report 96/21, 1-107.	Although there are published reviews of bioacoustics, effects of general noise on animals including wildlife, and effects of military fixed wing aircraft on domestic animals and wildlife, much less research has been performed on the effects of other military noise on wildlife. Animals can be extraordinarily sensitive to sounds in some circumstances and quite insensitive to sounds in others circumstances. Noises generated by military equipment, having particular and, in some cases, unusual characteristics, cannot necessarily be assumed to have effects similar to noised generated by civilian activities. For these reasons, it is desiravle to better understand the effects of military noise on wildlife. Given knowledge of how military noise effects animals, the Army may assess the potential impacts of sound from their activities on local wildlife populations and act to minimize possible disturbances. A literature survey should address	General Literature Review	N/A	N/A	Rotary-wing aircraft (helicopter) noise consists of a complex mixture if continuous engine noise (usually turbine) and rapidly repeating impulse noise from the rotor blades, sometimes including nonlinear noise of rotor tips traveling near Mach 1.

Citation	Abstract	Species	Distance	DB	Response
	concerns of the public sector as to the effects of military noise on wildlife and to aid in designing future research in this area if desired.				
Manci, K.M., D.N. Gladwin, R. Villella and M.G. Cavendish. 1998. Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Review. USFWS Service National Ecology Research Center NERC 98/29 AFESC TR, 88-14.	Although scientists have researched some effects of noise on animals. Many data gap still exist on the overall effects of aircraft noise on wildlife. In addition, perceived inadequate analysis of the effects of aircraft noise on wildlife by the general public has resulted in delays of flight operation expansions. An information base on the effects of aircraft noise and sonic booms on various animal species is necessary to assess potential impacts to wildlife populations from proposed military flight operations. This, in a joint U.S. Air Force/U.S. Fish and Wildlife Service effort, the National Ecology Research Center conducted a literature search of information pertaining to animal hearing and the effects of aircraft noise and sonic booms on domestic animals and wildlife. Information concerning other types of noise was also gathered to supplement the lack of knowledge ion the effects of aircraft noise. The literature is summarized in this report to provide an overview of current knowledge. No attempt was made to evaluate the appropriateness or adequacy or the scientific approach of each study. A brief overview if the physics of sound and aircraft noise and sonic boom characteristics also is included to familiarize the reader with the terminology and concepts of aircraft noise and sonic boom impact analysis.	General	N/A	N/A	
National Science Foundation. 2009. Final Environmental Impact Statement for the Advanced Technology Solar Telescope, Haleakala, Maui.	Impacts to Biological Resources Section 4.3. Do not consider noise impacts to Nene and HHB. Interesting noise levels for alpine conditions in section 3.10	Hawaiian Petrel, Hawaiian Goose, Hawaiian Hoary Bat, Band-rumped Storm Petrel	80 m to burrow	83 dB (A) 5 feet from noise source	Limitation on construction noise at burrows within 80 meters of construction activities to no louder than 83 dB (A) measured at 5 feet from the source during incubation periods (April 20th through July 15th). Limiting construction noise around sunrise and sunset.

Citation	Abstract	Species	Distance	DB	Response
Palmer, A.G., D.L. Nordmeyer and D.D. Roby. 2003. Effects of jet aircraft overflights on parental care of peregrine falcons. Wildlife Society Bulletin 31, 499-509.	Concerns voiced by resource managers caused us to examine the hypothesis that low-altitude jet aircraft overflights affect parental care by peregrine falcons. Specifically, we studied effects on nest attendance, time-activity budgets, and provisioning rates of peregrine falcons (*Falco peregrinus*) breeding along the Tanana River, Alaska in 1995, 1996, and 1997. We detected subtle effects of jet overflights on peregrine falcon parental behavior, but found no evidence that overall attendance patterns differed depending on exposure to overflights. Nest attendance and time-activity budgets of peregrine falcons during periods of overflights differed from those of peregrines at reference nests (nests rarely overflown). Differences depended on stage of the nesting cycle and gender. During the incubation and brooding stages of the nesting cycle, males attended the nest ledge less when overflights occurred than did males from reference nests. Females attended the nest ledge more during overflown periods compared to females from reference nests. Additionally, while females were still brooding nestlings, they were less likely to be absent from the nest area during periods when overflights occurred than females from reference nests. Although we found differences in nest attendance and time-activity budgets between overflown and reference nests, we did not observe differences between periods with overflights and periods without overflights at the same nests. Nor did we detect a relationship between nest attendance and the number of overflights occurring within a given time period, the cumulative number of above-threshold noise events at each nest, or the average sound-exposure level of overflights. Furthermore, we found no evidence that nestling provisioning rates were affected by overflights.	Peregrine Falcon		85 dB	We detected subtle effects of jet overflights on peregrine falcon parental behavior, but found no evidence that overall attendance patterns differed depending on exposure to overflights.
Pater, L.L., D.K. Delaney, T.J. Hayden, B. Lohr and R.J. Dooling. 1999. Assessment of training noise impacts on the red-cockaded woodpecker: Preliminary results. CERL Technical Report	This report presents preliminary results of a multiyear study to determine the effects of certain kinds of training noise on the endangered Red-cockaded Woodpecker (RCW). This research shows that the basic technical approach to data	Red-cockaded Woodpecker	60 meters	≤ 85 db (A)	RCWs did not flush when military helicopters were more than 60 m from nest sites and SEL noise levels were lower

Citation	Abstract	Species	Distance	DB	Response
(TR) 99/51, ADA 367234.	gathering and analysis is appropriate and effective. Preliminary data suggest that measured levels of military training noise did not affect RCW nesting success and productivity. The RCW flushed infrequently and returned to their nests quickly.				than 85 dB (A) (102 dB, unweighted; Appendix C, Table C3).
Perkins, J.L. 2006.Effects of Military Training Activity on Red-cockaded Woodpecker Demography and Behavior and New Territory Formation in the Cooperatively Breeding Red-cockaded Woodpecker. Master's Thesis Virginal Polytechnic Institute and State University.	The red-cockaded woodpecker (*Picoides borealis*) is a federally endangered species. As such, populations need to be increased in order to achieve recovery goals outlined by the U.S. Fish and Wildlife Service. My thesis is composed of two chapters that represent opposite sides of this issue. The first chapter investigates whether military training activity negatively affects red-cockaded woodpeckers. Military installations in the southeastern United States contain several of the largest remaining red-cockaded woodpecker populations. Six of the 15 installations harboring these birds are designated primary core populations; thus, population increases on these sites are critical to recovery of the species. However, restrictions on military training activity associated with red-cockaded woodpecker protection are a cause of concern on military installations that sometimes constrains management for population growth. Current restrictions are based on assumptions of potential impacts rather than scientific evidence, so we evaluated two different restriction regimes to test for training activity effects. The second chapter concerns how to induce populations to grow more rapidly through natural processes. As a cooperative breeder, red-cockaded woodpeckers preferentially compete for existing breeding positions and queue in the form of helping or floating to obtain a breeding vacancy, rather than create new territories. I used 20 years of demographic data collected as part of a long-term monitoring study of red-cockaded woodpeckers to investigate mechanisms that stimulate territory creation in this cooperatively breeding species.	Red-cockaded Woodpecker			More frequent disturbance from military training activity could have caused incubating birds in experimental clusters to flush from their nests, resulting in shorter mean incubation bout lengths than control clusters. However, this shorter incubation bout length did not translate into any effect at the demographic level, likely because experimental clusters compensated by Incubating a total amount of time similar to control clusters.

Citation	Abstract	Species	Distance	DB	Response
Radle, A.L. 2007. The Effect of Noise on Wildlife a Literature Review. University of Oregon, Environmental Studies Department. [updated March 2007, cited March 2011] Available from: http://interact.uoregon.edu /medialit/wfae/library/articles /radle_effect_noise_wildlife.pdf.	Noise pollution, as it effects humans, has been a recognized problem for decades, but the effect of noise on wildlife has only recently been considered a potential threat to animal health and long-term survival. Research into the effects of noise on wildlife, which has been growing rapidly since the 1970s, often presents conflicting results because of the variety of factors and variables that can effect and/or interfere with the determination of the actual effects that human-produced noise is having on any given creature. Both land and marine wildlife have been studied, especially in regards to noise in the National Parks System and the onslaught of human- made cacophony in the oceans from military, commercial and scientific endeavors.	General Literature Review			
Trimper, P.G., N.M. Standen, L.M. Lye, D. Lemon T.E. Chubbs and G.W. Humphries. 1998, Effects of Low-Level Jet Aircraft Noise on the Behavior of Nesting Osprey. The Journal of Applied Ecology 35, 122-130.	Nesting osprey (*Pandion haliaetus* L.) were exposed to controlled low-level CF-18 jet aircraft overflights along the Naskaupi River, Labrador, Canada, during 1995. Jet aircraft flew near five nests at distances ranging from 2.5 nautical miles (nm) to directly overhead at speeds of 400-440 knots. 2. Maximum noise levels (L1) and other noise metrics were influenced by many factors including topography, distance, altitude, wind speed and direction. 3. Based on 240 h of observations from blinds, we recorded osprey nest attendance and egg exposure during 139 individual overflights. Similar observations were completed at two control nests. Overflights as low as 30 m above ground occurred during incubation, nestling and prefledging only when observers were present. 4. Osprey behaviour did not differ significantly (P = 0.126) between pre- and post-overflight periods. Despite L1 values occasionally exceeding 100 decibels, adult osprey did not appear agitated or startled when overflown. 5. Osprey were attentive to and occasionally flushed from nests when float planes, other osprey or raptors entered territories, and when observers were entering or exiting blinds	Osprey		Median 89 dB at nest Range 66.3 to 95.5 dB	Despite L1 values occasionally exceeding 100 decibels, adult osprey did not appear agitated or startled when overflown.

Citation	Abstract	Species	Distance	DB	Response
U. S. Air Force, U. S. Army, and U. S. Department of the Navy. 1978. Environmental protection: Planning in the noise environment. Document Prepared under Air Force Contract No. F49642-74-90035.	This manual is a procedural tool designed to aid the creation of acceptable noise environments. It is written primarily for installation planners and other individuals concerned with the noise environment. It should be useful to persons involve with environmental assessments.	General			
U.S Fish and Wildlife. 2007. Biological Opinion for Maverick Airstar Landing Site in the Little Colorado River Gorge, Coconino County, Arizona. US Fish and Wildlife Service, Phoenix, AZ, Reference: AESO/SE 22410-2007-F-0352.	Biological Opinion for operating helicopters along the CO river. Has conservation measures and a take statement for harassment to Mexican Spotted Owls.	Mexican Spotted Owl	105 m	83 dB	Owls have more sensitive hearing than other birds (Bowles 1995). After reviewing the current status of the MSO, the environmental baseline for the action area, the effects of the proposed tourism helicopter landings and the cumulative effects; it is the FWS's biological opinion that tourism helicopter landings, as proposed, are not likely to jeopardize the continued existence of the MSO.
U.S. Fish and Wildlife Service. 2008. Biological Opinion of the U.S. Fish and Wildlife Service for Reinitiating of Formal Section 7 Consultation for Additional Species and new Training Actions at Pohakuloa Training Area, Hawaii. US Fish and Wildlife, Honolulu, HI, Reference: 2008-F-278.	Biological Opinion for Army live-fire training when Nene are in proximity to Range 1 at Pohakuloa Training Area.	Hawaiian Goose (Nene)	50 ft (15 m)		Nene within PTA and Keamuku Maneuver Area are permitted to be less than 50 ft (15 m) from detonations of demolitions, grenades, mortars, artillery, tube-launched wire-guided missiles, bombs, fire suppression and training related helicopters, and loud voices.

Citation	Abstract	Species	Distance	DB	Response
					When noise is too loud or disruptive, the nene will leave the premises or if they are habituated to the noise, then they are not losing any metabolic resources.
Ward D.H., R.A. Stehn and W.P. Erickson. 1999. Response of Fall-staging Brant and Canadian Geese to Aircraft Overflights in Southwestern Arizona. Journal of Wildlife Management 63, 373-381.	Because much of the information concerning disturbance of waterfowl by aircraft is anecdotal, we examined behavioral responses of Pacific brant (*Branta bernicla nigricans*) and Canada geese (*B. canadensis taverneri*) to experimental overflights during fall staging at Izembek Lagoon, Alaska. These data were used to develop predictive models of brant and Canada goose response to aircraft altitude, type, noise, and lateral distance from flocks. Overall, 75% of brant flocks and 9% of Canada goose flocks flew in response to overflights. Mean flight and alert responses of both species were greater for rotary-wing than for fixed-wing aircraft and for high-noise than for low-noise aircraft. Increased lateral distance between an aircraft and a flock was the most consistent predictive parameter associated with lower probability of a response by geese. Altitude was a less reliable predictor because of interaction effects with aircraft type and noise. Although mean response of brant and Canada geese generally was inversely proportional to aircraft altitude, greatest response occurred at intermediate (305-760 m) altitudes. At Izembek Lagoon and other areas where there are large concentrations of waterfowl, managers should consider lateral distance from the birds as the primary criterion for establishing local flight restrictions, especially for helicopters.	Brant and Canadian Geese	305-760 m altitude		Increased lateral distance between an aircraft and a flock was the most consistent predictive parameter associated with lower probability of a response by geese. Altitude was a less reliable predictor because of interaction effects with aircraft type and noise. Although mean response of brant and Canada geese generally was inversely proportional to aircraft altitude, greatest response occurred at intermediate (305-760 m) altitudes.

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IMPC-HI-PS 10 June 2011

MEMORANDUM FOR RECORD

SUBJECT: Hawaiian Petrel Surveys for HAMET Environmental Assessment

Surveys to assess the presence and habitat use of the Hawaiian dark-rumped petrel (*Pterodroma sandwichensis*) and the Hawaiian band-rumped petrel (*Oceanodroma castro*) were conducted on 25-26 May 2011 and 06-07 June 2011 at Mauna Loa landing zones LZ 1, LZ 2 and LZ 3, and at Mauna Kea landing zones LZ 4, LZ 5 and LZ 6, by Peter Peshut, PhD, Lena Schnell, BA, Rogelio Doratt, MSc, Daniel Brown, MSc, Sarah Knox, BSc, Bridget Frederick, BSc, and Martha Kawasaki, BSc. Surveys were conducted to determine petrel presence and habitat use in the general vicinity of the proposed LZs. Surveys were conducted as follow-up to preliminary surveys conducted in March 2011, to account for the seasonality of bird behavior (Simons, 1985; Slotterback, 2002). Surveys were conducted during four nights at each LZ between sundown and 9:00 pm encompassing Hawaiian petrel's peak calling period (Simons and Hodges, 1998).

Mauna Kea LZs are on State of Hawaii land in the Mauna Kea Forest Reserve, in the vicinity of the Mauna Kea Science Reserve. Mauna Loa LZs are on State of Hawaii land in the Mauna Loa Forest Reserve, adjacent to the Kipuka Ainahou Nene Sanctuary. Approximately 20% of the Mauna Loa LZ3 survey area is within the sanctuary. Landing zone geographic coordinates are given in Table 1. Landing zone locations are shown graphically in Figure 1. Each LZ is a graded or undisturbed lava area approximately 150 x 150 ft.

Table 1. Landing Zone Geographic Coordinates

Landing Zone	Latitude (N)	Longitude (W)	Elevation (ft)
Mauna Loa LZ1	19° 36' 05.64"	155° 28' 14.64"	7889
Mauna Loa LZ2	19° 36' 00.48"	155° 28' 37.74"	8049
Mauna Loa LZ3	19° 34' 32.10"	155° 29' 21.78"	8955
Mauna Kea LZ4	19° 49' 26.24"	155° 31' 23.51"	11,208
Mauna Kea LZ5	19° 49' 28.31"	155° 31' 47.00"	11,324
Mauna Kea LZ6	19° 49' 12.11"	155° 31' 16.31"	11,539

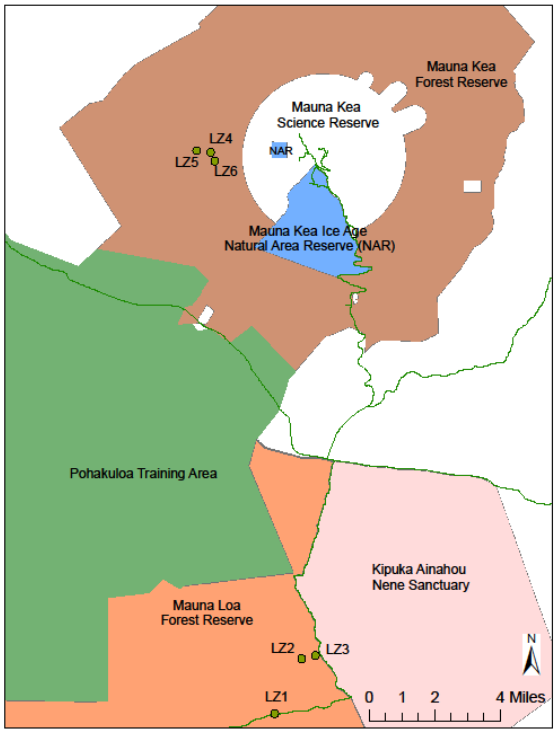

Figure 1. Mauna Kea and Mauna Loa HAMET Landing Zones.

Potential impacts to Hawaiian petrels as a result of HAMET operations are limited to disturbance from noise, and airstrikes. Noise and airstrike potential were evaluated based on the expected presence of petrels within the LZ survey areas during HAMET operations.

Airstrike as a result of HAMET operations is not considered to be of concern for Hawaiian petrels. Most HAMET activities are scheduled for daylight hours when helicopters are visible as well as audible to birds. Moreover, petrels that are transiting the saddle region are not expected to be in the vicinity of the LZs during daylight hours. Petrels in the vicinity of Mauna Kea LZs during nighttime operations are not anticipated, because of elevation. The expectation is that birds will transit the lower elevations of the saddle region, rather than the summits. Transiting petrels in the vicinity of Mauna Loa LZs during nighttime HAMET operations are expected to be minimal, because petrel density in the flyway is expected to be low (Cooper et al., 1996). As discussed in previous correspondence, bird airstrikes are extremely rare for military aircraft in Hawaii overall, with only two airstrikes documented between 2001-2010 for all Army aircraft flights in the state of Hawaii (Peter Mansoor, CW4, personal communication, 2011). Moreover, helicopters are typically slow-moving at the LZ elevations proposed for

HAMET, due to reduced aircraft performance (Frank Tate, COL, personal communication, 2011), which further reduces the likelihood of a bird airstrike.

Artificial light sources will not be placed at the LZs, as this is not consistent with realistic combat conditions (Frank Tate, COL, personal communication, 2011). Therefore, no impacts to seabirds from artificial light sources will occur.

Although it is recognized that exceptions are possible among individual species, the 80 dB contour was selected as the reasonable noise level threshold of concern for disturbance of bird species for the purposes of these surveys, based on a review of the literature (see Peshut and Schnell Memorandum For Record 04 April 2011). Given the expected low density of petrels within the survey areas, noise ≥80 dB will affect only an indeterminably small number of individuals.

No petrels were observed transiting the survey areas, and no petrel colonies were observed at any of the LZs during any survey period. Results are considered conclusive with respect to petrel colonies, and support the proposition that petrel occurrence in the saddle region flyway is infrequent.

Please contact Peter Peshut, 808-969-1966, peter.peshut@us.army.mil, for further discussions on HAMET operations and potential impacts to Hawaiian avifauna.

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Cooper, B.A., R.E. David, R.J. Blaha. 1996. Radar and Visual Surveys of Endangered Seabirds and Bats in the Pohakuloa Training Area, Hawaii, during Summer 1995. Prepared for R.M. Towill Corporation, Honolulu HI.

Simons, T.R. and C.N. Hodges. 1988. Dark-rumped Petrel (*Pterodroma phaeopygia*), The Birds of North America Online (A. Poole, Ed). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/345doi:10.2173/bna.345.

Simons, T. R. 1985. Biology and Behavior of the Endangered Hawaiian Dark-rumped Petrel. The Condor 87, 229-245.

Slotterback, J.W. 2002. Band-rumped Storm-Petrel (*Oceanodroma castro*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://0-bna.birds.cornell.edu.catalog.library.colostate.edu/bna/species/673adoi:10.2173/bna.673.

Appendix G

Spatial Data References

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Appendix G

Spatial Data References

Table D-1 shows the data sources used to generate the maps and figures not otherwise referenced for the High-Altitude Mountainous Environment Training (HAMET) environmental assessment. The information is presented in alphabetical order according to map legend title.

Table D-1. Spatial data references for HAMET maps.

Legend Item	Data Source
N/A: 100-ft elevation contour	*Elevation Contours, 100 foot interval*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
N/A: 500-ft elevation contour	*Elevation Contours, 500 foot interval*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
N/A: Recreation polygons (Figures 3-20, 4-5, and 4-6)	*Reserves*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 4, 2011.
1-5 km proposed trail buffer	*Historic Sites Review of a Proposed Mauna Loa Trail System*, T. S. Dye & Colleagues, Archaeologists, Inc., Figure 2 (p. 10), March 25, 2005.
Access road	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
Adze quarry (location marked with text label only)	*Mauna Kea Science Reserve Master Plan*, State of Hawai‘i Department of Land and Natural Resources Historic Preservation Division, Institute for Astronomy, University of Hawai‘i, Appendix F, Figure 1 (p. 2), March 2000.
Airport	*Geographic Place Names*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
‘Akiapola‘au habitat (bird)	*Bird Habitat (Version 2)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Astronomy Precinct	*Mauna Kea Comprehensive Management Plan: UH Management Areas*, Figure 5-1 (p. 5-21), University of Hawai‘i, January 2009.
Bradshaw Army Airfield	*BradshawAirfield*, Pōhakuloa Training Area Integrated Training Area Management Geodatabase 2010, U. S. Army 25th CAB, as provided to Portage, Inc., on October 7, 2010.
Burned area (Summer 2010)	Mauna_Kea_33_Perimeter_082510.shp, U.S. Army 25th CAB, as provided to Portage, Inc., on October 21, 2010.
City or town	*Cities*, ESRI Data and Maps 10 [CD-ROM], Environmental Systems Research Institute, Redlands, CA, June 2010.
County of Hawai‘i General Plan District	*Judicial Districts*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 31, 2011.
Cultural feature	*Historic Sites Review of a Proposed Mauna Loa Trail System*, T. S. Dye & Colleagues, Archaeologists, Inc., Figures 2 and 3 (pp. 10-11), March 25, 2005.
Cultural feature identified during 2011 PTA survey	“Memorandum for the Record: Cultural Resources Reconnaissance Survey of Existing High Altitude Mountainous Environmental Training (HAMET) Landing Zones (LZ) on Mauna Kea, [TMK (3) 4-4-015:001], Ka‘ohe Ahupua‘a, Hāmākua District, Hawai‘i Island,” D. M. Crowell, Department of the Army, February 24, 2011.
Cultural site (large)	*Historic Sites Review of a Proposed Mauna Loa Trail System*, T. S. Dye & Colleagues, Archaeologists, Inc., Figures 2 and 3 (pp. 10-11), March 25, 2005.

Table D-1. (continued).

Legend Item	Data Source
Existing trail	*Historic Sites Review of a Proposed Mauna Loa Trail System*, T. S. Dye & Colleagues, Archaeologists, Inc., Figure 3 (p. 11), March 25, 2005.
Federal land	*Large Landowners*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Forest reserve	*Reserves*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 4, 2011.
Glider activity area	*Hawaiian Islands 83.tif*, Sectional Raster Aeronautical Chart of the Hawaiian Islands, Federal Aviation Administration (http://avn.faa.gov/index.asp?xml=aeronav/applications/VFR/chartlist_sect), 83rd Edition, effective 10/21/2010 to 05/05/2011.
Haleakalā National Park	*Reserves*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 4, 2011.
Haleakalā Wilderness	wilderness_1997.shp, National Park Service Natural Resource-GIS Data Server (http://nrdata.nps.gov, “hale” directory), as published April 13, 2011.
HAMET flight path, Alternative 2: Mauna Kea only	Kea_flightpaths_from_Army_07mar11.shp, Portage, Inc., HAMET Project Geodatabase, March 8, 2011. Coordinates for the flight paths and associated check points were provided to Portage, Inc., via e-mail by the U.S. Army 25th CAB on March 8, 2010.
HAMET flight path, Alternative 3: Mauna Loa only	Loa_flighpath_corrected_with_Army_email_07mar11.shp, Portage, Inc., HAMET Project Geodatabase, March 8, 2011. Coordinates for the flight paths and associated check points were provided to Portage, Inc., via e-mail by the U.S. Army 25th CAB on March 8, 2010.
HAMET flight path checkpoint	Kea_waypoints_from_Army_07mar11.shp & Loa_waypoints_corrected_with_Army_email_07mar11.shp, Portage, Inc., HAMET Project Geodatabase, March 8, 2011. Coordinates for the flight paths and associated check points were provided to Portage, Inc., via e-mail by the U.S. Army 25th CAB on March 8, 2010.
HAMET flight path, Preferred Alternative: Mauna Kea and Mauna Loa	Kea_flightpaths_from_Army_07mar11.shp & Loa_flighpath_corrected_with_Army_email_07mar11.shp, Portage, Inc., HAMET Project Geodatabase, March 8, 2011. Coordinates for the flight paths and associated check points were provided to Portage, Inc., via e-mail by the U.S. Army 25th CAB on March 8, 2010.
HAMET landing zone (proposed)	*MV-22 Site Evaluation Report for US Army Garrison Hawai‘i*, The Boeing Company; Department of the Navy, Figures 1-213, 1-218, 1-223 (pp. 1-325, 1-331, and 1-337), November 30, 2009. Coordinates for Mauna Kea landing zones were provided to Portage, Inc., via e-mail by the U.S. Army 25th CAB on October 14, 2010.
HAMET noise model (42 day, 18 night)	HAMET_NoiseContours_01apr11_60FPD_42day_18night.shp, Portage, Inc., HAMET Project Geodatabase, April 1, 2011. These data were exported from NMPlot, the output portion of the DoD’s NoiseMap modeling software, to ESRI ArcGIS format on April 1, 2011. Parameters used to develop noise contours included seven daytime and three nighttime flights to each of the six LZs per day, for a total of 42 daytime and 18 nighttime flights per day.
Hawai‘i Volcanoes National Park	havo_parkboundary.shp, National Park Service Natural Resource-GIS Data Server (http://nrdata.nps.gov, “havo” directory), as published March 15, 2011.

Table D-1. (continued).

Legend Item	Data Source
Hawai‘i Volcanoes Wilderness	HAVO_Wilderness.shp, National Park Service Natural Resource-GIS Data Server (http://nrdata.nps.gov, “havo” directory), as published March 15, 2011.
Highway	*Roads – Major (USGS)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 14, 2011.
Historic District boundary	*Preliminary Draft Report: A Cultural Resources Management Plan for the University of Hawai‘i Management Areas on Mauna Kea, Ka‘ohe Ahupua‘a, Hāmākua District, Hawai‘i Island, State of Hawai‘i - A Sub-Plan for the Mauna Kea Comprehensive Management Plan*, Pacific Consulting Services, Inc.; Office of Mauna Kea Management, University of Hawai‘i at Hilo, Figure 2-4 (p. 2-32), July 2009.
Historic property	*Mauna Kea Comprehensive Management Plan: UH Management Areas*, Figure 5-1 (p. 5-21), University of Hawai‘i, January 2009.
‘Io habitat (bird)	*Bird Habitat (Version 2)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Lake Waiau	LakeWaiau_fromDOQQ.shp, Portage, Inc., HAMET Project Geodatabase, interpreted from U.S. Army Corps of Engineers DOQQ, Mauna_Kea_SW, (Honolulu District, Technical Integration Group, 1/9/2002), October 20, 2010.
Land ownership	*Large Landowners*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Local road	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
Mauna Kea Science Reserve	MK_Science_Reserve.shp, Office of Mauna Kea Management (University of Hawai‘i), as provided to Portage, Inc., on March 10, 2011.
Mauna Kea Visitor Center	MaunaKea_VisitorCenter.shp, Portage, Inc., HAMET Project Geodatabase, interpreted from Google Maps (TM) and mosaicked United States Department of Agriculture image, ortho_big_island (USDA-FSA Aerial Photography Field Office, 06/14/2004, http://hawaii.wr.usgs.gov/hawaii/data.html), March 22, 2011.
Mauna Loa Observatory	MaunaLoa_Observatory_Point.shp, Portage, Inc., HAMET Project Geodatabase, interpreted from Google Earth (TM), November 5, 2010.
Na Ala Hele Trail System	*Na Ala Hele Trails and Access System*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 1, 2011.
Natural reserve	MK_NAR1.shp, Office of Mauna Kea Management (University of Hawai‘i), as provided to Portage, Inc., on March 10, 2011.
Nēnē habitat (bird)	*Bird Habitat (Version 2)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/); as published October 1, 2010.
Nēnē sanctuary	*Reserves*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 4, 2011.
Noise monitoring location	HAMET_FinalNoiseMonitoringLocsGPS_03212011.shp, Portage, Inc., HAMET Project Geodatabase, March 23, 2011. Noise monitoring locations were surveyed by Portage, Inc., personnel using a Trimble GeoXT GPS unit during field activities on 03/19/2011 through 03/21/2011.
NPS trail from TIGER Roads	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010. Extracted based on interpretation of imagery from Google Earth (TM) and: trail.shp, National Park Service Natural Resource-GIS Data Server (http://nrdata.nps.gov, “havo/nrdata/water/baseline_wq/gis” directory), as published March 15, 2011.

Table D-1. (continued).

Legend Item	Data Source
Other cultural resource	*Mauna Kea Comprehensive Management Plan: UH Management Areas*, Figure 5-1 (p. 5-21), University of Hawai‘i, January 2009.
Other trail	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
Palila critical habitat	*Critical Habitat*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Park or reserve	*Reserves*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published March 4, 2011. MK_NAR1.shp, Office of Mauna Kea Management (University of Hawai‘i), as provided to Portage, Inc., on March 10, 2011. (Used for Mauna Kea Ice Age Natural Area Reserve boundary only.)
Plant location	*All_listed_plants*, Pōhakuloa Training Area Integrated Training Area Management Geodatabase 2010, United States Army 25th CAB, as provided to Portage, Inc., on October 7, 2010. *Biological Assessment for Section 7 Consultation on High Altitude Aviation Training (HAATs) on Mauna Kea*, Hawai‘i Department of Public Works, Environmental Division, Aviation Brigade 25th Infantry Division Aviation, Figure 3 (p. 16), December 2007.
Pōhakuloa Training Area	*mil_restricted_access_area*, Pōhakuloa Training Area Integrated Training Area Management Geodatabase 2010, U.S. Army 25th CAB, as provided to Portage, Inc., on October 7, 2010.
Primary road	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
Private land	*Large Landowners*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Proposed trail	*Historic Sites Review of a Proposed Mauna Loa Trail System*, T. S. Dye & Colleagues, Archaeologists, Inc., Figure 2 (p. 10), March 25, 2005.
Restricted air space	*RestrictedAirSpace*, Pōhakuloa Training Area Integrated Training Area Management Geodatabase 2010, U.S. Army 25th CAB, as provided to Portage, Inc., on October 7, 2010.
Saddle Road, new section	*Placemarks_line*, Portage, Inc., HAMET Project Geodatabase, interpreted from Google Earth (TM), March 14, 2011.
Secondary road	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
Soil type	*Soils*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
State land	*Large Landowners*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
State land (Dept. of Hawaiian Homelands)	*Large Landowners*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Threatened and endangered plants	*Threatened and Endangered Plants*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
Traditional cultural property	*Mauna Kea Comprehensive Management Plan: UH Management Areas*; Figure 5-1 (p. 5-21), University of Hawai‘i, January 2009.
Trail (TIGER roads)	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.
Vehicular trail	*TIGER Roads (2002)*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 5, 2010.

Table D-1. (continued).

Legend Item	Data Source
Viewpoints	*Geographic Place Names*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.
Waiki‘i (settlement)	*Geographic Place Names*, Hawai‘i Statewide GIS Program Online Server (http://hawaii.gov/dbedt/gis/), as published October 1, 2010.

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