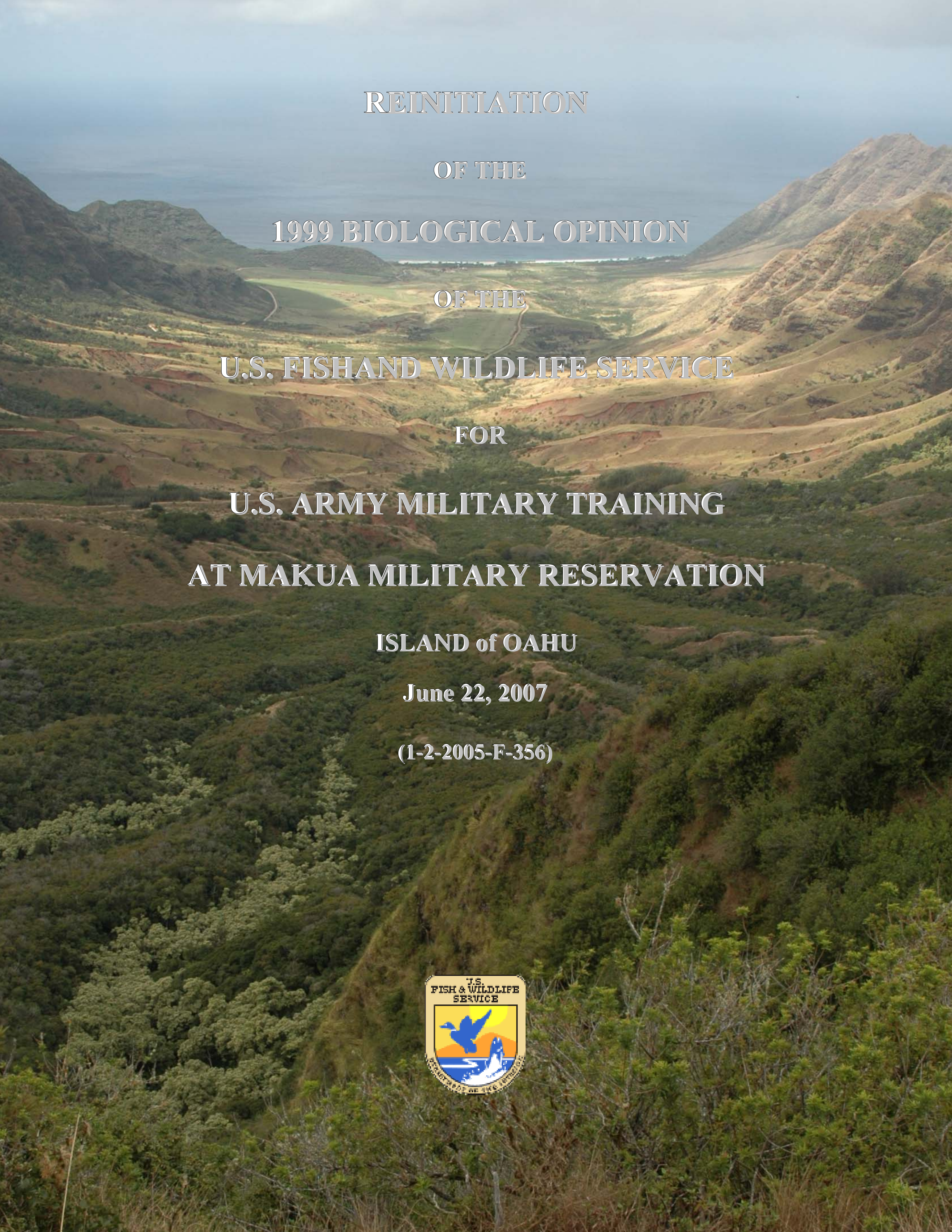

REINITIATION

OF THE

1999 BIOLOGICAL OPINION

OF THE

U.S. FISHAND WILDLIFE SERVICE

FOR

U.S. ARMY MILITARY TRAINING

AT MAKUA MILITARY RESERVATION

ISLAND of OAHU

June 22, 2007

(1-2-2005-F-356)

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122
Box 50088
Honolulu, Hawaii 96850

TAKE PRIDE® IN AMERICA

In Reply, Refer to:
1-2-2005-F-356

JUN 22 2007

Colonel Howard J. Killian
U.S. Army Commander
Department of the Army
Headquarters, United States Army Garrison, Hawaii
Schofield Barracks, Hawaii 96857-5000

Subject: Reinitiation of the Biological Opinion of the U.S. Fish and Wildlife Service for Military Training at Makua Military Reservation (1-2-2005-F-356)

Dear Colonel Killian:

This Biological Opinion responds to your request for reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) pursuant to section 7 of the Endangered Species Act of 1973, as amended. We initiated consultation on August 22, 2005. Between the initiation date and June 2007, there were many modifications to the Project Description pertaining to training, fire suppression, and ensuing conservation measures. The majority of these modifications were resolved by January 2007; however, pursuant to our meeting with you on May 15, 2007, in actuality we did not have a final Project Description until June 15, 2007. We requested an extension to this consultation since we could not complete an analysis of the effects of the action until we had a final Project Description of Army actions at Makua Military Reservation (Makua).

The following three formal consultations were completed over the past nine years and establish the foundation for this reinitiated Biological Opinion.

1. "The Biological Opinion of the U.S. Fish and Wildlife Service for Routine Military Training at Makua Military Reservation" (1-2-99-F-01) (Service 1999b) on July 23, 1999, which addressed ongoing training activities conducted by the U.S. Army (Army) to 37 listed plants, Oahu tree snail (*Achatinella mustelina*), Oahu creeper (*Paroreomyza maculata*), Hawaiian hoary bat (*Lasiurus cinereus semotus*) and a conference opinion on the proposed endangered Oahu elepaio (*Chasiempis sandwichensis ibidis*).

2. A "Supplement to the Biological Opinion and Conference Opinion for Proposed Critical Habitat of the U.S. Fish and Wildlife Service for Routine Training at Makua Military Reservation" (1-2-99-F-01-S) (Service 2001b) was completed in October 2001. The 2001 Supplement addressed several modifications to the original action including the elimination of tracer bullets and tube-launched, optically tracked, wire guided missiles or TOW missiles and the discovery of two additional listed plant species in the action area.

The 2001 Supplement included a conference opinion that addressed training impacts to proposed critical habitat for the Oahu elepaio.

3. We completed a "Reinitiation of the 1999 Biological Opinion of the U.S. Fish and Wildlife Service for Routine Military Training at Makua Military Reservation Island of Oahu" (1-2-2004-F-006) (Service 2004a) dated September 24, 2004, in which we consulted on the critical habitat for 41 plants and the Oahu elepaio.

This reinitiation addresses the effect of routine training to 38 threatened and endangered plant species plus 36 plant critical habitats (Appendix A), the Oahu elepaio and its designated critical habitat, and the Oahu tree snail. For ease of reference, all other species (native and non-native) discussed in this Biological Opinion, are listed in Appendix B.

This reinitiation is based on the following documents:

1) Biological Assessment for Programmatic Section 7 Consultation on Routine Military Training at Makua Military Reservation (U.S. Army Garrison 1998) (November 2, 1998);

2) The above referenced 1999 Biological Opinion, 2001 Supplement, and the 2004 reinitiation on critical habitat;

3) Makua Endangered Species Mitigation Plan (May 4, 1999), renamed the Makua Endangered Species Stabilization Plan (U.S. Army Garrison 1999a);

4) Draft PFC Pililaau Range Standard Operating Procedures (U.S. Army Garrison 2001) (June 2001);

5) Integrated Wildland Fire Management Plan Oahu and Pohakuloa Training Areas (U.S. Army Garrison 2003a) (October 2003);

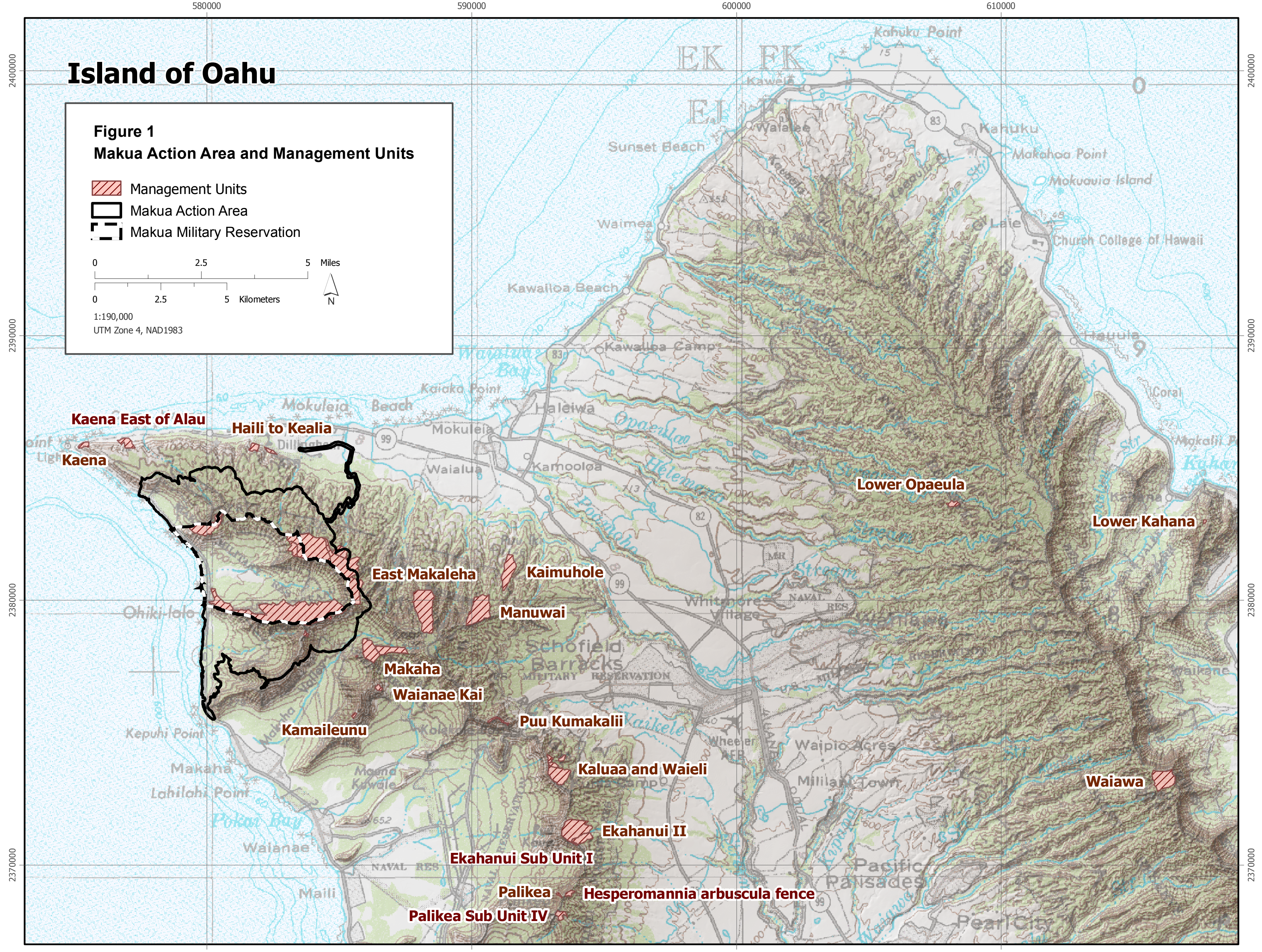
6) Implementation Plan Makua Military Reservation Island of Oahu (Makua Implementation Team 2003) (May 2003);

7) Makua Implementation Plan Addendum, Makua Military Reservation, Island of Oahu (U.S. Army Garrison 2005a); and

8) Informal consultation between the U.S. Army (Army) and the Service; and other sources of information in our files.

Action Area Summary

The action area pursuant to our section 7 regulations consists of "all areas to be affected directly or indirectly by the Federal action," which include land proposed as management units as delineated in the Makua Implementation Plan Addendum (Figure 1). To facilitate the analysis of increased training actions and implementation of the Makua Implementation Plan we divided the Makua action area into two distinct areas: 1) the area that will be impacted by the direct and indirect affects of military training; and 2) the area containing the management units that are


Island of Oahu
Figure 1
Makua Action Area and Management Units
Management Units
Makua Action Area
Makua Military Reservation
0 2.5 5 Miles
0 2.5 5 Kilometers
N
1:190,000
UTM Zone 4, NAD1983
Kaena East of Alau
Haili to Kealia
Kaena
East Makaleha
Kaimuhole
Manuwai
Makaha
Waianae Kai
Kamaileunu
Puu Kumakalii
Kaluaa and Waieli
Ekahanui II
Ekahanui Sub Unit I
Palikea
Hesperomannia arbuscula fence
Palikea Sub Unit IV
Lower Opaeula
Lower Kahana
Waiawa
580000
590000
600000
610000
2400000
2390000
2380000
2370000

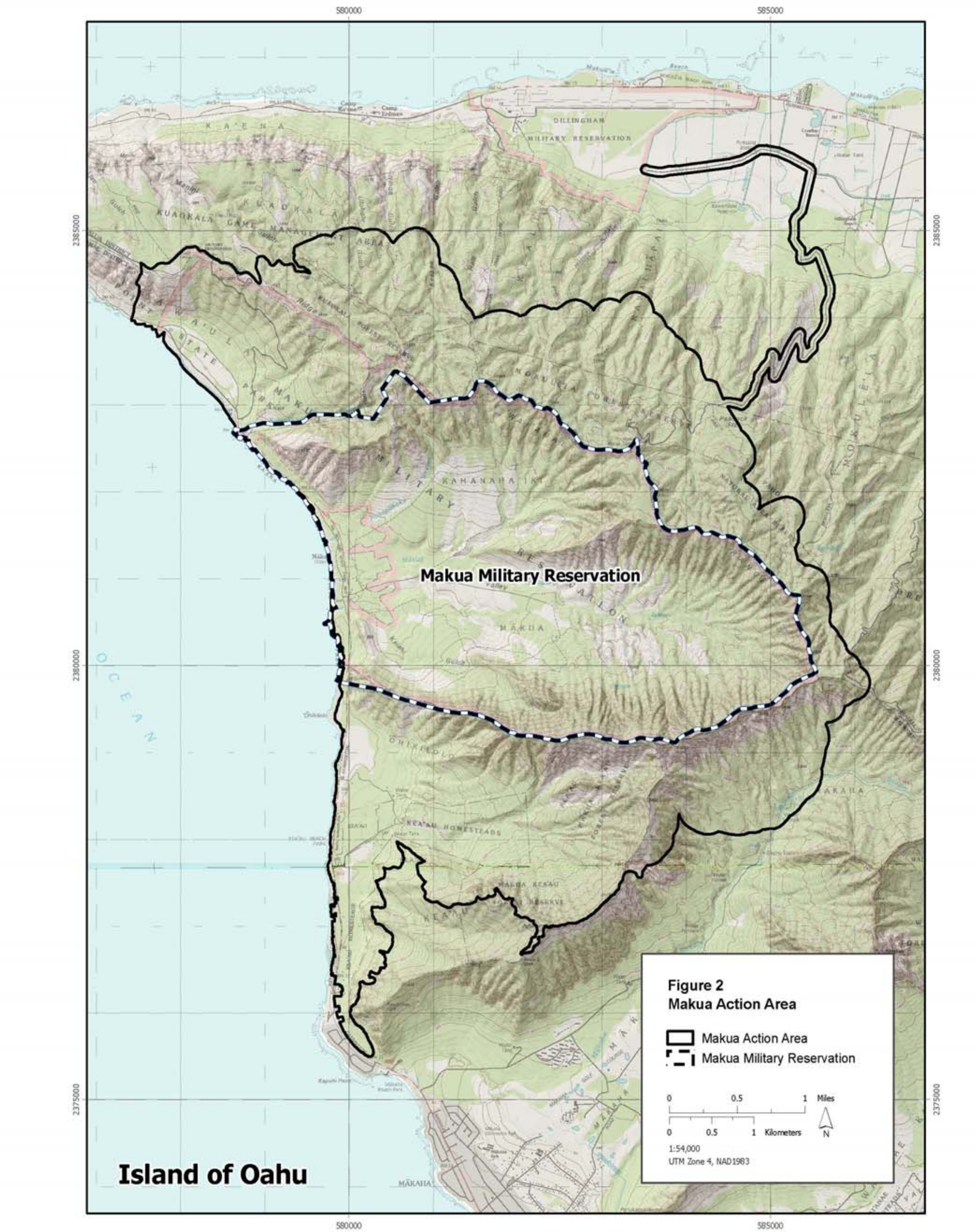
located outside of the training area (see Figure 1). These management units are proposed for eventual stabilization of plant and snail species as discussed in the 1999 Biological Opinion and presented in detail in the Makua Implementation Plan and the Makua Implementation Plan Addendum. We have determined that the activities conducted by the Army's Natural Resources Staff will not have any detrimental effect to listed species or designated critical habitat within the "management unit" action area. We came to this conclusion because any threat reduction pursuant to the Makua Implementation Plan (e.g., fence building, ungulate removal, invasive plant removal, rat baiting) that is implemented in these areas will benefit species and critical habitat by enhancing conditions for both the species and the primary constituent elements of the critical habitat. The Army's Natural Resources Staff are trained in resource conservation and they understand that no adverse impacts may result from any proposed work in these areas. If they determine that an action "may adversely affect" a listed species or designated critical habitat, they will coordinate with us prior to implementing that action. The portion of the action area that encompasses the management units outside of the training action area, and the listed species or critical habitat that may overlap or coincide with these areas will not be considered further in this consultation. From here on out, the term "action area" refers to the training action area as depicted on Figure 2.

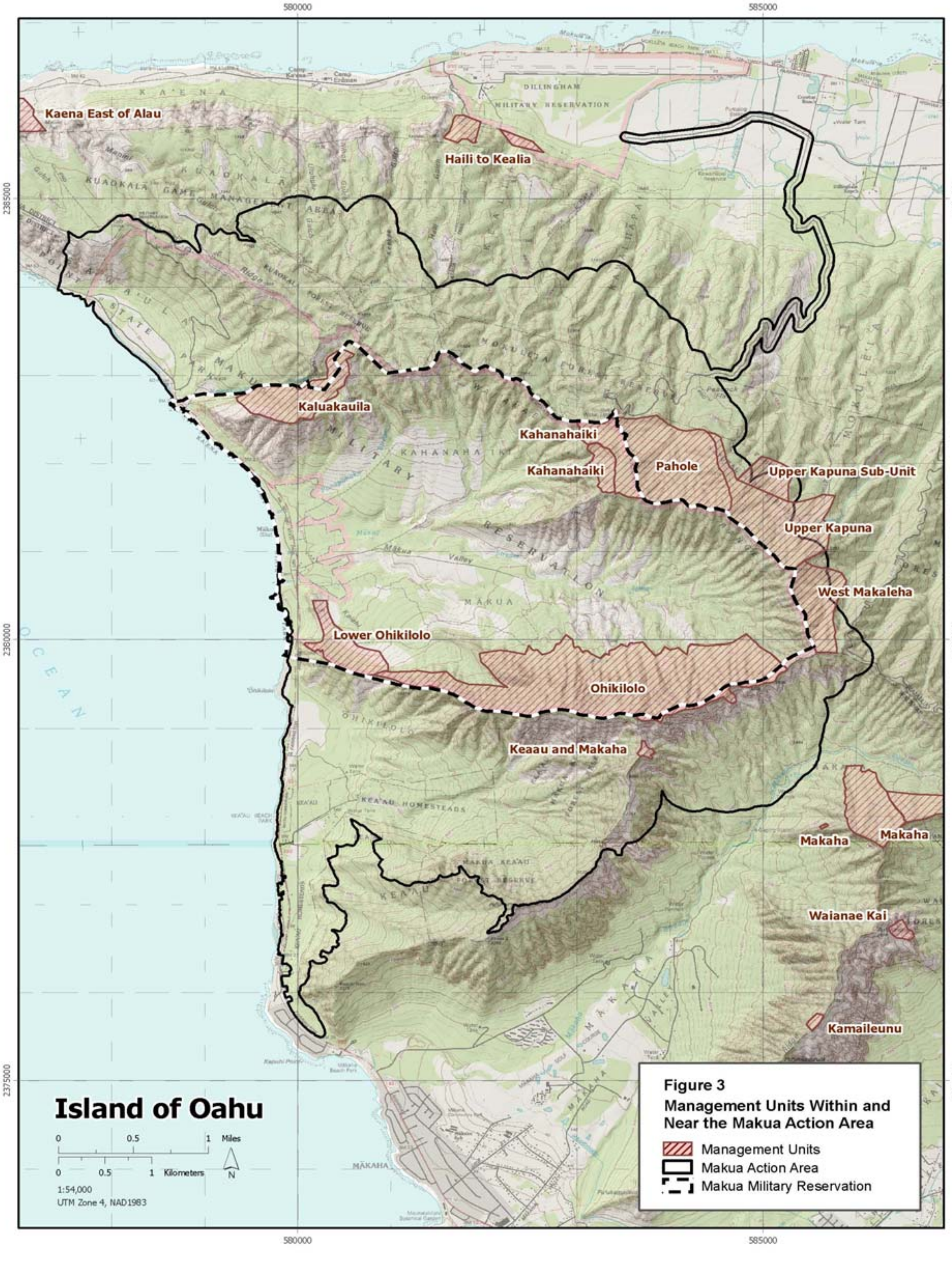
The Service determined the training action area for this consultation by running the fire spread model Fire Area Simulator (FARSITE) (Finney 1998). This model takes into account the area that would be impacted by an unsuppressed fire ignited at the outer perimeter of the potential ignition area for all weapons, with high risk weather conditions. The model calculated fire spread based on hourly inputs of weather data and Geographic Information System (GIS) generated maps of vegetation fuels, canopy characteristics, slope, elevation, and aspect.

The Kuaokala Trail was added to the action area since this area will be utilized by troops as they conduct forced marches. The trail initiates from Dillingham Airfield and terminates at the upper rim of the Makua Valley. These marches will be conducted twice a month also by a company of soldiers. Smoking will not be allowed on the trail and soldiers will be trained to clean shoes and equipment to limit the spread of exotic, invasive plant seeds. The action area associated with the trail is 100 meters (m) (328 feet (ft)) wide, spanning 50 m (164 ft) from the center of the trail.

Management Units

Figure 3 depicts the management units within, or adjacent to, the action area proposed by the Makua Implementation Team and outlined in the Makua Implementation Plan Addendum. Some of these units, such as Pahole (which is operated by the State of Hawaii), were already being managed to protect sensitive species prior to their establishment as a management unit. The Army is implementing management activities such as fencing, ungulate removal and outplanting of listed plant species within the management units. A portion of this work has been conducted pursuant to the Army's obligations as stipulated in the urgent actions that were developed during the three-year period the Makua Implementation Plan was being written and finalized. All of these actions benefit plant and elepaio critical habitat that overlap the management units.


580000
585000
2385000
2380000
2375000
DILLINGHAM
MILITARY RESERVATION
Makua Military Reservation
OCEAN
Island of Oahu
Figure 2
Makua Action Area
Makua Action Area
Makua Military Reservation
0 0.5 1 Miles
0 0.5 1 Kilometers
1:54,000
UTM Zone 4, NAD1983
N


Island of Oahu
Figure 3
Management Units Within and Near the Makua Action Area
Management Units
Makua Action Area
Makua Military Reservation
Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Makaha
Waianae Kai
Kamaileunu
1:54,000
UTM Zone 4, NAD1983
Miles
Kilometers
580000
585000
2385000
2380000
2375000

This Biological Opinion will supersede all previous biological opinions and incorporate all modifications to training and natural resources activities that will occur within the action area. For our analysis we have incorporated the Wildland Fire Management Plan, the Makua Implementation Plan Addendum, plus relevant portions of the Makua Implementation Plan for our analysis. A complete administrative record of this consultation is on file at our office.

This reinitiated Biological Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service* (No. 03-35279) to complete the following analysis with respect to critical habitat.

CONSULTATION HISTORY

See Appendix B for a complete list of list of individuals mentioned below and their positions within their respective organizations.

July 26, 2005: The Service received a letter of reinitiation outlining proposed changes to training actions at Makua. The Army requested the addition of tracers, illumination munitions, Javelins, inert TOW missiles, 60 mm short-range training ammunition, 155 mm High Explosive (HE) artillery simulators, 2.7-caliber rockets shot from helicopters, training on C-ridge, training with ball ammunition without helicopter support, demolition without helicopter support, and night training. The reinitiation package also included a proposed reduced action area.

August 5, 2005: We received the biological information (companion document to the reinitiation letter) for the plant and animal species that will be affected by the Army's increased training activities at Makua. This was the start date for the reinitiation.

September 20, 2005: The U.S. Department of the Interior submitted a 15-page comment letter on the "Draft Environmental Impact Statement on Military Training Activities at Makua Military Reservation, Hawaii." (ER05/0631)

October 3, 2005: Representatives from the Service (Patrice Ashfield, Stephanie Bennett, Patty Walcott, and Jenness McBride) met with Tom Huseman (Makua Range Manager) for a tour of Makua. We also discussed the use of certain weapons at Makua and Mr. Huseman agreed that use of illumination rounds and the Javelin would be inappropriate at a range the size of Makua.

October 14, 2005: Patrice Ashfield, Gina Shultz, Steve Miller, Jenness McBride, Patty Walcott (Service), met with Michelle Mansker, Peter Yuh, Joel Godfrey, Jason Greenlee, Susan Ching (Army) to present our action area that differed from the proposed action area submitted by the Army with the reinitiation package. Our determination increased the action area due to our understanding of the proposed action (long-range, incendiary weapons) and the potential for fire spread due to disturbed grassy vegetation in and adjacent to Makua. We also presented a risk analysis for the endangered plant, *Schiedea nuttallii* outlining our concern that the action as proposed could result in a jeopardy determination for this species. We recommended the removal of tracers, 155 mm artillery, illumination rounds, 2.75-caliber rockets and Javelins from the proposed action.

November 14, 2005: The Service detailed a National Park Service Fire Management Officer (Dawn Greenlee) to assist with the fire related issues pertaining to the Makua consultation.

November 17, 2005: Michelle Mansker, Environmental Resource Manager, relayed to Patrice Ashfield (Service) that Colonel Killian agreed to remove illumination rounds from the list of training weapons at Makua.

December 6, 2005: Without notifying the Service, the Army placed a wooden bridge on the Kaena Trail to allow troop movement on the trail. We notified the Army that construction and use of the bridge was inappropriate prior to completion of the consultation since Kaena Trail was part of the new action.

December 8, 2005: Army biologists (Kapua Kawelo, Susan Ching, and Michelle Mansker) met with Service representatives (Patrice Ashfield, Charmie Dang, Jenness McBride, Stephanie Bennett, and Patty Walcott) for a day to work through problems associated with the data base and to ensure we are using the best available information on species abundance and distribution.

December 15, 2005: Service representatives, Patrice Ashfield, Gina Shultz, Dawn Greenlee met with Army representatives, Michelle Mansker, Gayland Enriques (Army Fire Chief), Jason Greenlee, and Susan Ching to discuss the draft fire suppression helicopter staffing guidelines that could enable fires to be contained under various live herbaceous fuel moisture and weather conditions.

December 27, 2005: The Service received a request from the Army to conduct a prescribed burn outside of the firebreak road in order to fulfill their Settlement Agreement and Stipulated Order to allow concerned citizens access to archaeological sites at Makua. The Army was concerned this type of prescribed burn would be too risky for species and fire fighting personnel.

January 3, 2006: The Service replied to the Army's letter concurring that a "hot" burn outside of the firebreak road was a problem and would require extensive minimization measures.

January 25, 26 and 27, 2006: The annual Makua Implementation Team meetings to discuss the Army's progress implementing the Makua Implementation Plan occurred. Team members represented included: Department of Land and Natural Resources Division of Forestry and Wildlife, Board of Water Supply, The Nature Conservancy, University of Hawaii, U.S. Geological Survey Biological Resources Discipline, the Service, and the Army.

January 30, 2006: The Service received a letter from the Army requesting our review of the Prescribed Burn Plan MMR 06-01, to ensure that the proposed plan was not likely to adversely affect listed species or critical habitat. The burn was proposed for periods of time when the grass in the valley, outside the burn unit, was green, and adequate fire suppression helicopter staffing was proposed so that a spot fire could be contained before listed plants could burn.

February 9, 2006: Andy Beavers (Center for Environmental Military Managed Lands; CEMML), Kapua Kawelo (Army Environmental), Jason Greenlee (Army Wildland Fire Management Officer), Dawn Greenlee (Service) took a field trip to the Kahanahaiki weather station fuelbreak area and the Kaluakauila firebreak site. They later visited the Army wildland fire crew, led by Scott Yamasaki, completing guinea grass cutting work below the Hibiscus patch in the Lower Ohikilolo Management Unit. They discussed fuelbreak needs for these three areas.

February 24, 2006: The Service (Jenness McBride, Gina Shultz and Patrice Ashfield) presented “expedited stabilization” to Army representatives, Michelle Mansker, Joel Godfrey, and Elena Onaga (Army solicitor) for 12 plant species at risk of extirpation due to increased training activities.

March 1, 2006: At the request of Jason Greenlee and Dawn Greenlee, Nezette Rydell (Warning Coordination Meteorologist, National Weather Service, Honolulu) and Jeffrey Powell (Fire Weather Focal Point, National Weather Service, Honolulu) developed a spot weather forecast system to provide fire weather forecast variables for all individual hours, and a narrative description of any expected diurnal wind shifts for all future prescribed burns at Makua. These new spot fire weather forecasts met the National Weather Service spot fire weather forecast standards.

March 1, 2006: Service representatives Jenness McBride and Patrice Ashfield met with Army biologists (Susan Ching, Kapua Kawelo, and Michelle Mansker) to discuss expedited stabilization as a methodology to allow incendiary weapon use without extirpating plant species from Makua from training related wildfires.

March 8, 2006: A prescribed burn was attempted at Makua when live herbaceous fuel moisture was 122 percent. The Army determined the grass was too green to get a clean burn within the burn unit, so herbicide was sprayed on the grass in the unit to decrease moisture and allow the grass to go brown. Rainfall the night before the burn prevented the burn from being completed.

April 18, 2006: Dawn Greenlee (Service) met with Michelle Mansker and Jason Greenlee (Army) to discuss alternative systems for protecting the Kaluakauila and Kahanahaiki management areas perimeters from fire, shrub restoration test sites, and prescribed burn prescription parameters.

April 27, 2006: Jason Greenlee (Army) and Dawn Greenlee (Service) met with Nezette Rydell (Warning Coordination Meteorologist, National Weather Service) and Jeffrey Powell (Fire Weather Focal Point, National Weather Service), to confirm that the local National Weather Service Office could develop the capability to input “F” type forecast observations into the Makua WIMS weather station for hours when training would be occurring at Makua.

April 27, 2006: LTC Sal Petrovia (Army G3 training), Elena Onaga (Army Solicitor), Joel Godfrey, Michelle Mansker, and Jason Greenlee (Army) met with Gina Shultz, Patrice Ashfield, and Dawn Greenlee (Service) to discuss issues with the proposed Project Description. As a result of the meeting, the use of tracers from helicopters was removed from the Project Description; the Army agreed that only pilots qualified in the use of 2.75-caliber rockets would fire this weapon at Makua; and the Service agreed that maintenance of grass height to one foot or less within 60 m (197 ft) along the inside edge of the south lobe of the firebreak road would provide adequate firebreak protection.

May 3, 2006: Michelle Mansker, Kapua Kawelo, Jason Greenlee, Scott Yamasaki Army), eight members of the Army wildland fire crew, Colleen Bergmannis (Army ITAM), and Dawn

Greenlee (Service) took a field trip to the Kahanahaiki weather station fuelbreak area, the Kahanahaiki Management Unit, and the Makua valley overlook at the southwest corner of the Pahole Management Unit to discuss various systems to protect the management unit perimeters from fire. A combination of fuelbreaks and firebreaks was selected.

June 1, 2006: Bill Boulet (Installation Safety Office), Elena Onaga (Army Solicitor), Tom Piskel (Army contractor), Jason Greenlee, Peter Yuh, LTC Sal Petrovia, and Michelle Mansker (Army) met with Patrice Ashfield, Jenness McBride and Dawn Greenlee (Service) to discuss weapon firing points and potential ignition areas. A list of weapons was proposed for firing from a point within the north lobe of the firebreak road. An increase in size of the action area was discussed, given the request by the Army to use Javelin and TOW weapons at Makua. As a result of this meeting .50 caliber tracers were removed from the Project Description.

June 21, 2006: Dawn Greenlee (Service) attended a demonstration mortar shoot at Schofield Barracks with Army personnel including the Makua Range Control Supervisor Bert Borja, Tom Piskel (Army contractor), Sammy Houseberg and Jason Greenlee (Army Fire and Safety).

August 17, 2006: Dawn Greenlee (Service) and Andy Beavers (CEMML) complete an updated fuel model map for the Makua area, extending the area covered, refining the accuracy of the polygons, and incorporating the new fuel models published in 2005 by Scott and Bergen.

September 21, 2006: A draft Project Description was sent to the Army for review.

November 2, 2006: The Service received the 2006 Status Reports for the Makua Implementation Plan and the Draft Oahu Implementation Plan prepared by the Army’s Environmental Division.

October 18, 2006: Boone Kauffman (Director and Research Ecologist, Institute of Pacific Islands Forestry, USDA Forest Service, Pacific Southwest Research Station, Hilo), Pat Costales (Oahu District Manager, Division of Forestry and Wildlife, DLNR), Francis M. Fujioka (Research Meteorologist, U.S. Forest Service, Pacific Southwest Research Station, Riverside, CA), Andy Beavers (CEMML), Sammy Houseberg (Army Fire and Safety Office), Eric Moller (Army Fire Chief), Jason Greenlee and Michelle Mansker (Army), and Dawn Greenlee (Service) met to discuss updates to the guinea grass fuel model and helicopter staffing requirements made as a result of rates of spread and helicopter productivity on fires observed during the 2006 fire season. Future guinea grass and molasses grass fuel model rate of spread and live herbaceous fuel moisture work, and habitat restoration projects within the Kahanahaiki, Kaluakauila and Lower Ohikilolo management units were discussed.

December 6, 2006: A successful prescribed burn was completed within the south lobe of the firebreak road. The Army followed all of the requirements specified by Prescribed Burn Plan MMR 06-01. Live herbaceous fuel moisture was 163 percent outside the burn unit, and the area inside the burn unit had been browned by herbicide.

December 7, 2006: Patrice Ashfield and Dawn Greenlee (Service) met with Ray Rubinoff (Army, Washington Office) and Michelle Mansker (Army) to discuss various aspects of the Army’s proposed project.

January 22, 23, and 24, 2007: The Makua Implementation Plan Team met to discuss progress of Army Natural Resources endangered species conservation efforts pursuant to the Makua Implementation Plan Addendum.

February 1, 2007: The Army provided the Service with written comments on hard copies of the Project Description. Dawn Greenlee (Service) met with Michelle Mansker and Kapua Kawelo (Army) to discuss changes to the Project Description, including the removal of the Kaena point trail from the project, the addition of language that permits future updates to the guinea grass fuel model with subsequent updates to fire suppression helicopter staffing requirements, and provision for the detonation of unexploded ordinance outside the firebreak road.

April 16, 2007: The Service provided the Army with two compact disks containing the draft Project Description. Comments from Army reviewers (Michelle Mansker, Jason Greenlee, Elena Onaga, and G3 trainers) were incorporated the Project Description.

May 3, 2007: Scott Yamasaki (Army Wildland Fire Management Officer) emailed the Service requesting wildland fire related modifications to the Project Description.

May 4, 2007: Dawn Greenlee (Service) met with Scott Yamasaki and Michelle Mansker (Army) to negotiate changes to the Project Description recently proposed by both agencies.

May 15, 2007: Gina Shultz and acting Deputy Field Supervisor Steve Oberholtzer (Service) met with Colonel Killian to discuss the use of tracers from helicopters, the guinea grass fuel model, and helicopter fire suppression. The Army followed up with an email to Gina Shultz that included a written review of their issues and concerns pertaining to the Project Description on May 17, 2007.

May 24, 2007: The Service emailed a response to the May 17, 2007, Army email. The Service agreed to allow small caliber tracers to be shot from helicopters and a reduction in helicopter staffing.

June 4, 2007: Patrice Ashfield (Service) and Michelle Mansker (Army) discussed the problem pertaining to five plant species that are located in a high fire risk area and thus in need of some additional fire minimization measure. It was decided that this measure would be finalized at a later date with the assistance of the Makua Implementation Team.

June 13, 2007: The Service received additional comments on the final Project Description and finalized the last outstanding concerns with Michelle Mansker on June 15, 2007.

For ease of reference, all species (native and non-native) discussed in this Biological Opinion, are listed in Appendix C.

PROJECT DESCRIPTION

1. Introduction

This Project Description outlines the Army's training and land management actions at the Makua Military Reservation (Makua). This Project Description incorporates pertinent information from the following documents:

- 1999 Makua Biological Opinion
- 2001 Supplement
- 2004 Critical Habitat Reinitiation
- Draft Environmental Impact Statement 2005
- 1998 Biological Assessment
- 2005 Reinitiation Package
- Standard Operating Procedures (SOPs)
- Integrated Wildland Fire Management Plan
- Makua Implementation Plan
- Makua Implementation Plan Addendum

Due to the risk of wildfire from incendiary munitions, avoidance and minimization measures have been included to reduce training-related impacts to listed species and critical habitats. The aforementioned documents, along with additional avoidance and minimization measures, taken together, provide a complete description of the proposed action. The following is a consolidation of the complete Project Description for the current proposed actions at Makua for the next 30 years.

1.1 Objective and Scope

The proposed action is to conduct military training, operations and maintenance at Makua. This Project Description differs from past actions we consulted on in that the Army is increasing its training activities at Makua and modifying its resource management, or "stabilization" activities, for 28 listed plants and the Oahu tree snail. Stabilization will be discussed in more detail in Section 7, but, in brief, stabilization criteria include the establishment and maintenance of a minimum number of mature, naturally reproducing individuals within a set number of populations where all major threats are controlled and fulfillment of specified genetic storage goals with *ex situ* representation of the taxon.

Fire suppression responsibilities and Army commitments in this discussion will further reduce the risk of training-related wildfire impacts to endangered species and critical habitats. This Project Description reintroduces the use of high explosive, long-range weapon systems eliminated in the 2001 consultation and includes several new weapons not previously used at Makua. Training and maintenance activities at Makua will have both direct and indirect effects to the species and critical habitat within the action area. Although training activities will only be conducted within a designated impact area, there is the risk of fire spreading to areas beyond the impact area due to the surrounding flammable fuels, strong winds, and topography. Therefore, incorporated into this action are updated weapons restrictions, new prescribed fire guidelines, new fuelbreaks and firebreaks, and updated fire suppression staffing measures to minimize the risk of a fire igniting outside of the firebreak road. It is anticipated that fires will occur within the south lobe of the firebreak road during training. It is also anticipated that most fires will not spread outside of the firebreak road area due to the weapons restriction and suppression measures incorporated into this Project Description. If fires do ignite outside the firebreak road, fire suppression helicopter staffing requirements and fuelbreaks have been designed to minimize the risk of fire to endangered species, management units, and areas of designated critical habitat. Indirect effects from training at Makua will include increased invasive plant seed dispersal, dust, noise, invasive vertebrate activity associated with humans such as rodents, mongoose, and pigs, and lighting (nighttime training).

In summary, the following actions are detailed in this Project Description: (1) expanded training actions, (2) live-fire and long-range weapon use, (3) minimization measures to reduce the inherent risk of fire ignition from live-fire weapon training, and (4) measures to ensure populations of endangered species and critical habitat will not be permanently lost as a result of training-related fires in the Makua action area.

1.2 Project Site and Management Description

Makua valley is approximately 1,696 hectares (ha) (4,190 acres (ac)) in size and is located on the northwest leeward side of Oahu (Figure PD 1). The Makua action area is 4,243 ha (10,486 ac) in size. Makua is bowl-shaped with steep, precipitous valley walls 640 to 884 meters (m) (2,100 to 2,900 feet (ft)) on the north, east and south sides of the valley floor. The Pacific Ocean borders on the western side of the valley. The mouth of the valley is dry, with less than 38 centimeters (cm) (15 inches (in)) of precipitation. Annual precipitation increases to 127 cm (50 in) towards the head of the valley (U.S. Army Garrison 1998). A firebreak road surrounds the active training area, or impact area, and all activities and weapon target practice occurs within this area (see Figure PD 1). The Army trains primarily within the Private First Class or PFC Pililaau Range Complex that is a 185-ha (457-ac) training course in the southwestern portion of the impact area. Makua is used for both live-fire and non-live-fire maneuver training exercises. Training activities are conducted only within the impact area or within the firebreak road.

The Kuaokala Trail, northeast of Makua, will be used for forced marches by troops. It begins at Dillingham Airfield and terminates at the upper rim of the Makua valley. This trail may be used for marches twice a month by a company of Soldiers (150 Soldiers). Smoking will not be allowed on the trail, and troops will be trained to clean equipment and shoes in order to limit the spread of exotic, invasive plant seeds. The action area associated with the trail is 100 m (328 ft) wide, spanning 50 m (164 ft) from the center of the trail.

Lower elevation areas of the action area are dominated by non-native grasslands, and intact native shrub and forest vegetation remains on higher elevation ridgelines (see Figure PD 1). The Service and Army collaborated to develop an updated fuel model map for the Makua area (Figure PD 2). Fuels were classified based on the type of vegetation fire ecologists anticipated would carry the fire under high wind and low fuel moisture conditions.

Figure PD 1. Hawaii GAP land cover map.

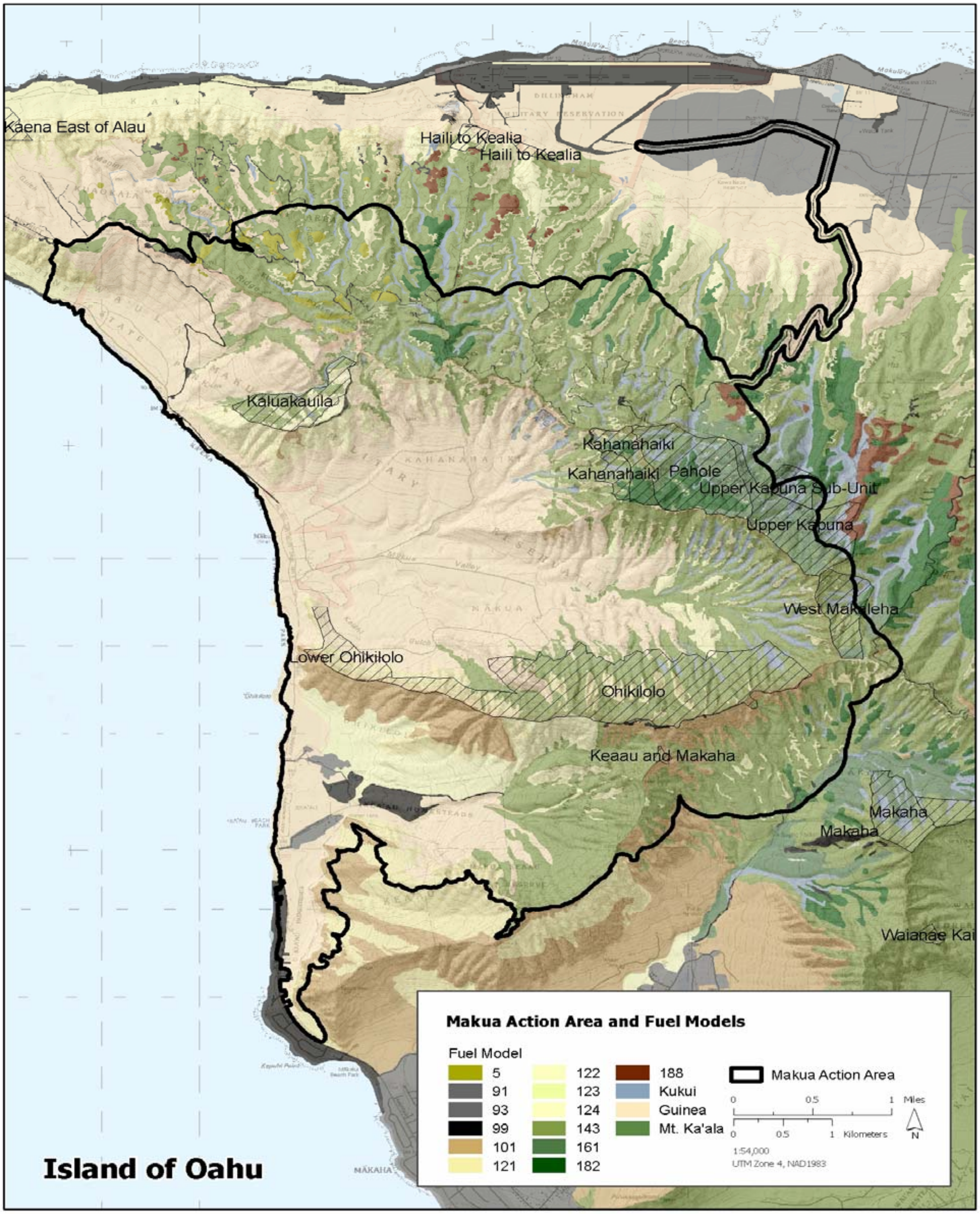


Figure PD 2. Fuel model map.

Standard fuel models (Scott and Burgan 2005) were used to classify much of the landscape. Custom fuel models were used to classify guinea grass (Beavers 2001, with fuel bed depth modified as described in Project Description Section 9) and kukui forests (Beavers unpublished). The Makua action area contains 1,514 ha (3,741 ac) of area mapped as guinea grass fuel model, 781 ha (1,930 ac) of other grass fuels, 1,441 ha (3,560 ac) of low and mid-elevation shrub and forest fuels, and 371 ha (917 ac) of forest fuels with light understory fuel loading.

2. General Description of Training Activities

Makua is used for both live fire and blank ammunition training. Military units travel to the training area by both surface and air. All types of units, including field artillery, air defense artillery, engineer, infantry, military intelligence, military police, transportation, quartermaster (supply), signal (radio communication), chemical (smoke screen generation), and aviation, use Makua. The maximum training level at Makua would include 300 Soldiers (combination of Battalion Headquarters or command and control, force multipliers (e.g., artillery, Kiowas, and howitzers), and a company (80 to 150 persons) with a total of approximately 150 Soldiers training with live fire at any one time. In addition, training will include squad (5 to 10 persons) and platoon-level (20 to 40 persons) scenarios.

Other non-Army military units will also use Makua for training. In the past, the U.S. Marine Corps, U.S. Navy, U.S. Coast Guard, Army Reserve, and Hawaii Army National Guard have trained at Makua. It is likely that forces from other countries hosted by the Army as part of the U.S. Pacific Command Theater Security Cooperation Plan would use this training resource from time to time. These military units would be limited to company-level Combined Arms Live-Fire Exercises (CALFEX) as the maximum level of training and would be required to adhere to all Makua-specific training constraints. The Army will be responsible for ensuring that all users of Makua adhere to the specifications in this Project Description.

Training will be conducted on the 186-ha (459-ac) impact area situated inside the south firebreak road. Some weapons may be fired from the designated mowed, irrigated firing point in the north lobe of the firebreak road (north lobe firing point). No weapon will be fired from any location outside the south lobe of the firebreak road or the north lobe firing point. All training scenarios are coordinated and synchronized so that all ammunition is aimed to land within the confines of the southern training lobe or impact area (Figure PD 3). Indirect fire weapons such as mortars and artillery have a potential range that is farther than the limits of the firebreak road. However, the direction and angle at which they are fired, and amount of powder bags that are used for each shot, are precautions used to limit the range of these weapons.

Training at Makua may take place for up to 242 days per year and activities may occur during the day or night. To minimize fire risk, full CALFEX activity will be limited by live herbaceous fuel moisture weapons restrictions to periods when grass fuels in the valley are relatively green and to periods when winds are lighter and fuel moisture is higher. Certain weapons will not be used until new firebreaks and fuelbreaks are installed and the expedited stabilization of particular species is completed. No live-fire training will occur until the on-site fire suppression helicopters have their fire suppression water buckets attached and successfully tested, and they are able to safely conduct fire suppression missions. Current flight limitations preclude the use of fire suppression helicopters prior to early twilight, approximately 30 minutes prior to sunrise. Night live-fire training will not be conducted until helicopters are authorized for night fire suppression.

2.1 Training Areas

Training exercises are staged in the impact area in eight areas that are referred to as objectives (see Figure PD 3). Maneuver training is conducted at five of the eight objectives: Deer, Fox, Coyote, Wolf, and Badger. Units are authorized to enter Objective Badger and set up fire support when attacking the final objective. Objective Deeds is used for support-by-fire and long-range (sniper) shooting. While Objectives Elk and Buffalo are closed for maneuver training due to the proximity of cultural resources, Objective Buffalo is used as a firing point. In addition to the established objectives, the Army can also create new objectives for training exercises as long as they are in conformance with this Biological Opinion and approved by the Service.

Figure PD 3. Objectives currently used as firing points and target areas.

In accordance with the 25th ID and U.S. Army Hawaii (USARHAW) Regulation 210-6, *Installation Ranges and Training Areas*, planning a typical training exercise at Makua begins at least eight weeks prior to the event. The Unit Commander provides a detailed written plan of the exercise scenario, which includes a maneuver and fire support plan; weapons, ammunition, and targets to be used; control measures and method of communication; limits of advance; and surface danger zones for all weapons systems. The Unit Commander also provides a risk assessment for the exercise. The risk assessment provides analysis of safety threats to Soldiers in combat situations. The Unit Commander's superiors (the Battalion and Brigade Commander, a

Lieutenant Colonel and Colonel, respectively), the Division Commander's Range Safety supervisors, and Range officer must approve the exercise plan.

2.2 Surface Danger Zones

The Makua Range Office or Officer in Charge develops a surface danger zone for each training event (in accordance with AR 385-64, *Ammunition and Explosives Safety Standards*) to determine the potential range and angle of a particular weapon. Surface danger zones delineate the impact area and additional buffer area where fragments from exploding rounds could land. They are developed to specify the area that would contain all but one in one million rounds fired and are used to ensure personnel safety. Firing point location, direction of fire, left and right limits of fire, powder bag settings, fragment dispersion, and firing angle are among the variables that may be used to develop the surface danger zone.

Surface danger zones are established through in-depth ricochet trials conducted at the Aberdeen Proving Ground and Yuma Proving Ground and analyzed by the Aeroballistics Division at the Armament Research, Development and Engineering Center. Surface danger zone development also takes into consideration the Army's range safety regulation and is incorporated into the Army's regulations (DA PAM 385-63).

The company provides the Range Office with the training scenario, including firing points and targets in accordance with the U.S. Army Hawaii and 25th ID Regulation 210-6, *Installation Ranges and Training Areas* (U.S. Army Garrison 1999b) and the Makua standard operating procedures. All targets are within the confines of the southern firebreak road. The Makua Range Office builds a surface danger zone to fit each training scenario and gives the unit a safety card. The safety card specifies the right and left firing limits for weapons as well as the minimum and maximum range for firing to ensure that the ordinance falls within the impact area.

Weapons surface danger zones consist of the following danger areas (Figure PD 4):

1) Target. This is the location where the weapon is to be fired. For demolitions, the target area is the point on location at which the demolition charge is placed.

2) Impact area. This is the primary danger area for indirect fire weapons established for the impact of all rounds. When applied to direct fire weapons, it is the area located between established range limits. The impact area is within the approved surface danger zone.

3) Dispersion area. This is a measure of the impact distribution in the dispersion pattern around the center of impact, dimensionally expressed in firing tables as one interval of the dispersion rectangle.

4) Area A. This is the secondary danger area which parallels the impact area laterally and which is provided to contain fragments from items exploding or ricocheting on the right or left edge of the impact area.

5) Area B. This is the secondary danger area situated on the down-range side of the impact area and Area A. It is designed to contain fragments from items exploding on the far edge of the impact area.

6) Area C. This is the secondary danger area situated on the up-range side of the impact area and parallel to Area B. It is intended to contain fragments from items exploding at the near edge of the impact area.

7) Area D. This is the area considered a safe area for troop occupation for training purposes.

8) Area E. This is the area between Area D and the firing position, which may be impacted by muzzle debris, overpressure, and injurious noise levels. Area E may be occupied only by weapon crews firing from an approved tactical configuration.

9) Area F. This is the area immediately to the rear of a weapon or group of weapons and may be impacted by the backblast effects of the weapon being fired.

10) Distance X. This is the maximum range of the weapon, given specific firing angle.

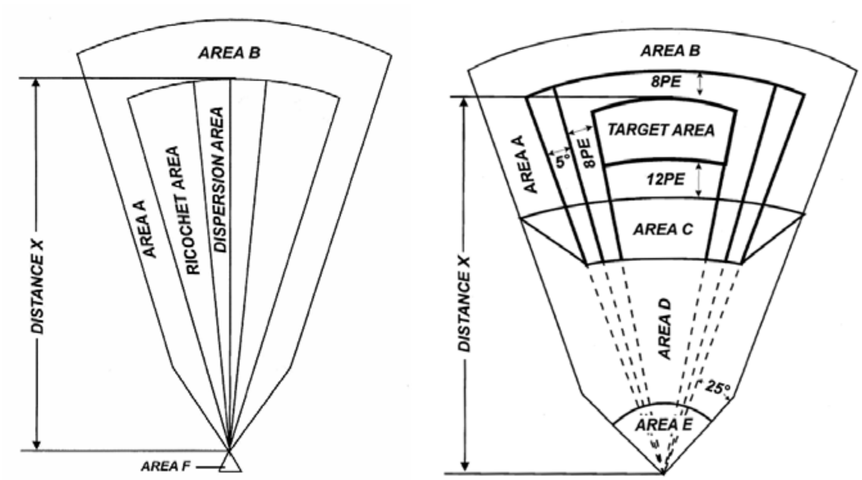


Figure PD 4. Examples of surface danger zone danger areas.

2.3 Firing Points

The designated North Firing Point (Figure PD 5), located within the north lobe of the firebreak road, will either be maintained bare of vegetation or it will be mowed and irrigated so that live herbaceous fuel moisture (of the grass over the entire area) is above 200 percent when in use. The firing point will be bounded directly along its north and east edges by a new improved firebreak road, 469 m (1,539 ft) long and following the route of an area historically used as an access road, maintained with bare ground to a width not less than 6 m (20 ft) (see Figure PD 5). An approximate 2.8-ha (7-ac) area will be cleared of unexploded ordinance, a new sprinkler system will be installed, and grass will be mowed so that live herbaceous fuel moisture is 200 percent or higher whenever the firing point is being used. The TOW, AT-4, and artillery will only be fired from the North Firing Point, and the Javelin may also be fired from this firing point.

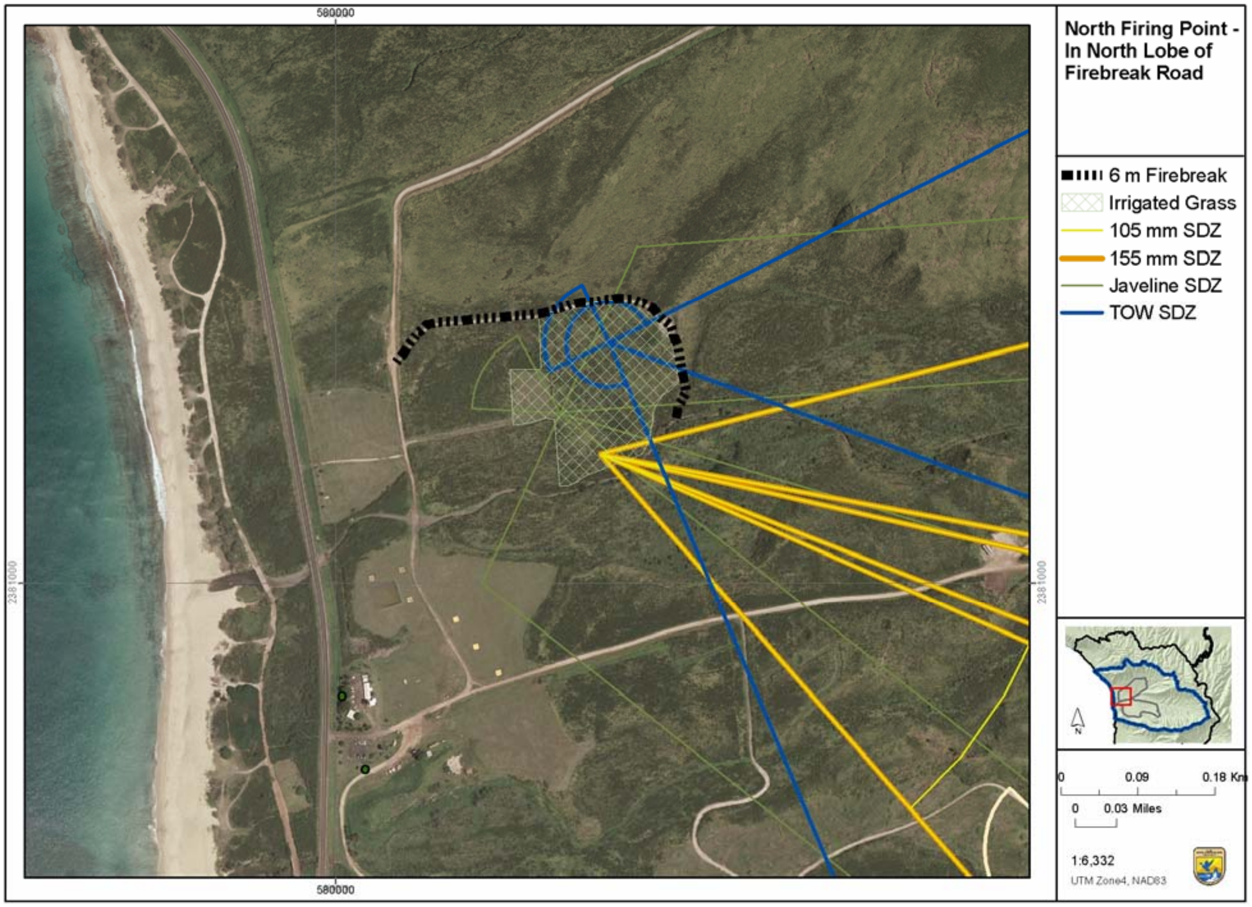


Figure PD 5. Designated 2.8-ha (7-ac) firing point in north lobe of firebreak road.

Blanks will generally be fired from designated mowed areas which are separated from patches of tall grass by a bare mineral soil firebreak, wide enough to stop a fire burning in the mowed grass fuels. This firebreak will be maintained with the application of herbicide or by mechanical means.

2.4 Weapons

Table PD 1 depicts the weapons and ammunition proposed for use at Makua. Weapons proposed for continued use at Makua, which are similar to those used from 2001 through 2004, include small arms ball ammunition, demolitions, grenades, mines, simulators, mortars, artillery, and anti-tank weapons. In addition, training at Makua will now include: tracers, 155 mm artillery, Javelin and TOW missiles, and 2.75-caliber rockets shot from helicopters.

Table PD 1. List of Weapons and Ammunition to be Used Under Certain Conditions at Makua.

Weapon	**Ammunition or Charge**
Small arms:	Ball bullets
Rifles	5.56 mm, 7.62 mm
Pistols	9 mm, .45-caliber, .38-caliber, .22-caliber
Machine guns	5.56 mm, 7.62 mm, .50-caliber, 40 mm target
	practice (TP)
Shotguns	12 gauge shotgun (00)
Helicopter guns	7.62 mm, .50-caliber
Tracer ammunition	5.56 mm, 7.62 mm, .50-caliber
Green ammunition	5.56 mm and 7.62 mm*
Short-range training ammunition (SRTA)	5.56 mm and .50-caliber
Mortars and artillery	60 mm HE and 60 mm SRTA (mortar)
	81 mm HE and 81 mm TP (mortar)
	105 mm HE (artillery)
	120 mm HE (mortar)*
	155 mm HE (artillery)*
	Artillery simulators
Anti-tank weapons	AT-4/M 136 (84 mm HE anti-tank rocket) SMAW
	Javelin*
	2.75-caliber rocket*
Shoulder-launched multipurpose assault weapon (SMAW)	Launcher assault rockets SMAW practice round
Inert TOW missile launcher	Inert TOW missile blast effect simulator
Smoke grenades	Colored, hexachloroethane smoke, white smoke, and target acquisition smoke practice
Grenades	Fragmentation, offensive, practice, simulators
Demolitions	Limit 300-pound (136-kilogram) net explosive weight, including bangalore torpedoes
Mines	Claymore antipersonnel, inert antipersonnel (volcano delivery device or modular packed mine system delivered), anti-tank

Notes: *With the exception of the green ammunition, 120 mm mortar, 155 mm artillery, 2.75-caliber rockets, and the Javelin, weapons listed in Table PD 1 have either been used in the past or are used currently for training at Makua. The Javelin would be phased in to replace the previously used Dragon, a similar weapon system.

2.5 Weapons Restrictions

Table PD 2 outlines the use of weapons at Makua and the restrictions of weapon use based on the following factors: (1) stabilization status of certain endangered species, (2) seasonal variability in grass greenness, and (3) hourly fire danger rating. Weapons that are likely to ignite wildland fires outside the firebreak road are not proposed for use until after the expedited stabilization of endangered plant species located near high fire risk zones is completed and new fuelbreaks and firebreaks are established to protect the Makua Implementation Plan management units. It is estimated that expedited stabilization for these species and fuelbreak establishment will take approximately five to 15 years to complete. Weapons with the greatest potential to ignite fires outside the firebreak road will not be used when live herbaceous fuel moisture, a measure of grass greenness, is lower than 100 percent. Only ball ammunition will be permitted when live herbaceous fuel moisture is less than 60 percent. Available historic fire weather data indicate that live herbaceous fuel moisture falls below 100 percent in the spring (between February 20 and May 7) and remains below 100 percent until the fall (between October 1 and November 10).

Table PD 2. Summary of Makua Weapons Restrictions.

Weapon Class	Weapon	Live Herbaceous Fuel Moisture (HRB) Calculated by WIMS at Makua Range Station # 490301 on the previous day:	Column A: Weapons to be used when grass is removed from within 3 meters of all *Hibiscus* and *Chamaesyce* plants in Lower Ohikilolo and reduced to less than 20% cover within *Hibiscus* and *Chamaesyce* Weed Control Areas in Figure x - Full on-site fire suppression helicopter staffing required for all weapons use.	Column B: Reduced Helcipter Staffing for Listed Weapons when 60 meters of fuel modification (grass mowing, etc) is completed along the inside perimeter of the south lobe of the firebreak road: One half of total fire suppression helicopter staffing required to be on-site, when weapons in use are restricted to only Blanks, Ball Ammunition, Demolitions in designated bare mineral soil areas inside south lobe of firebreak road, and Hand Grenades and Smoke Grenades in designated pits cleared to bare mineral soil.	Column C: To Be Implemented Only after Completing and Maintaining Column A and B requirements, and the additional requirements of: Completion of Kaluakauila and Kahanahaiki Management Unit Fuelbreaks and Firebreaks, Punapohaku area fire loss minimization measures, and Expedited Stabilization of *Cyanea superba subspecies superba, Schiedea nuttallii,* and *Schiedea obovata*.	Column D: To Be Used After Completing and Maintaining all Column A, B, and C requirements and the additional requirement of: Expedited Stabilization of *Chamaesyce herbstii, Cyanea grimesiana subspecies obatae, Cyanea longiflora, Cyanea superba ssp superba, Delissea subcordata, Gouania vitifolia, Hibiscus brackenridgei subsp. mokuleianus, Neraudia angulata, Phyllostegia kaalaensis, Sanicula mariversa, Schiedea nuttallii, Schiedea obovata*.	Column E: To Be Used After Completing and Maintaining all Column A and Column B requirements and the additional requirement of: Full Stabilization of all Makua Implementation Plan species.
Small Arms	Blanks	50% and higher	Blanks in mowed areas with firing pt. firebreak	Blanks in mowed areas with firing pt. firebreak	Blanks in mowed areas with firing pt. firebreak	Blanks in mowed areas with firing pt. firebreak	Blanks in mowed areas with firing pt. firebreak
			Blanks in other areas inside S. Lobe FB Road	Blanks in other areas inside S. Lobe FB Road	Blanks in other areas inside S. Lobe FB Road	Blanks in other areas inside S. Lobe FB Road	Blanks in other areas inside S. Lobe FB Road
	Rifles (including M24 sniper rifle, M16A2), 12 Guage Shot Gun	Ball Ammunition - 50% and higher	5.56 mm lead, and 5.56 SRTA, 7.62 mm lead, .308 lead, lead shot	5.56 mm lead, and 5.56 SRTA, 7.62 mm lead, .308 lead, lead shot	5.56 mm lead, and 5.56 SRTA, 7.62 mm lead, .308 lead, lead shot	5.56 mm lead, and 5.56 SRTA, 7.62 mm lead, .308 lead, lead shot	5.56 mm lead, and 5.56 SRTA, 7.62 mm lead, .308 lead, lead shot
		Tracers - 120% and higher			5.56mm, 7.62mm tracers: use only when live HRB fuel moisture 120% or higher	5.56mm, 7.62mm tracers: use only when live HRB fuel moisture 100% or higher	5.56mm, 7.62mm tracers: use only when live HRB fuel moisture 100% or higher
		Tracers - 100% and higher					
	Pistols (9 mm pistol)	Ball Ammunition - 50% and higher	9 mm lead, .45-caliber lead, .38-caliber lead, .22-caliber lead	9 mm lead, .45-caliber lead, .38-caliber lead, .22-caliber lead	9 mm lead, .45-caliber lead, .38-caliber lead, .22-caliber lead	9 mm lead, .45-caliber lead, .38-caliber lead, .22-caliber lead	9 mm lead, .45-caliber lead, .38-caliber lead, .22-caliber lead
	Machine Guns (including M249 SAW, M4/M4A1, M240B, M2, M16)	Ball Ammunition - 50% and higher	5.56 mm lead, 7.62 mm lead, .50-caliber lead	5.56 mm lead, 7.62 mm lead, .50-caliber lead	5.56 mm lead, 7.62 mm lead, .50-caliber lead	5.56 mm lead, 7.62 mm lead, .50-caliber lead	5.56 mm lead, 7.62 mm lead, .50-caliber lead
		Tracers - 120% and higher			5.56mm, 7.62mm tracers only: only when live HRB fuel moisture 120% or higher	5.56mm, 7.62mm, and .50 caliber M1 tracers only: only when live HRB fuel moisture 100% or higher (Only 5.56 and 7.62 mm tracers permitted for use from helicopters)	5.56mm, 7.62mm, and .50 caliber M1 tracers only: only when live HRB fuel moisture 100% or higher (Only 5.56 and 7.62 mm tracers permitted for use from helicopters)
		Tracers - 100% and higher					
Demolitions	EOD/UXO Demolition -outside firebreak road or within 100 m of road	100% and higher	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight
	EOD/UXO Demolition at least 100 m inside south lobe of firebreak road	60% and higher	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight	C4 and TNT: Limit 300-pound (136-kilogram) net explosive weight
	Training Demolition in demolition pit, tire house, or bunker	60% and higher	C4, TNT, detonation cord, blasting caps, time fuses, cratering charges, shape charges, bangalore torpedoes. Limit 300-pound (136kg) net explosive weight, including bangalore	C4, TNT, detonation cord, blasting caps, time fuses, cratering charges, shape charges, bangalore torpedoes. Limit 300-pound (136kg) net explosive weight, including bangalore	C4, TNT, detonation cord, blasting caps, time fuses, cratering charges, shape charges, bangalore torpedoes. Limit 300-pound (136kg) net explosive weight, including bangalore	C4, TNT, detonation cord, blasting caps, time fuses, cratering charges, shape charges, bangalore torpedoes. Limit 300-pound (136kg) net explosive weight, including bangalore	C4, TNT, detonation cord, blasting caps, time fuses, cratering charges, shape charges, bangalore torpedoes. Limit 300-pound (136kg) net explosive weight, including bangalore
Grenades	Hand Grenades in pit	60% and higher	Not Launched: Fragmentation, Practice, Offensive, Simulators	Not Launched: Fragmentation, Practice, Offensive, Simulators	Not Launched: Fragmentation, Practice, Offensive, Simulators	Not Launched: Fragmentation, Practice, Offensive, Simulators	Not Launched: Fragmentation, Practice, Offensive, Simulators
	Smoke Grenades in pit	60% and higher	Not Launched: Colored, hexachloroethane (HC) smoke, white smoke, and target acquisition (TA) smoke	Not Launched: Colored, hexachloroethane (HC) smoke, white smoke, and target acquisition (TA) smoke	Not Launched: Colored, hexachloroethane (HC) smoke, white smoke, and target acquisition (TA) smoke	Not Launched: Colored, hexachloroethane (HC) smoke, white smoke, and target acquisition (TA) smoke	Not Launched: Colored, hexachloroethane (HC) smoke, white smoke, and target acquisition (TA) smoke
	M79 and M203 Grenade launcher	60% and higher	40mm grenade M79 and M203	40mm grenade M79 and M203	40mm grenade M79 and M203	40mm grenade M79 and M203	40mm grenade M79 and M203
			M203 inert practice rounds (No live rounds or HE in Yellow)	M203 inert practice rounds (No live rounds or HE in Yellow)	M203 inert practice rounds (No live rounds or HE in Yellow when live HRB is less than 100%)	M203 inert practice rounds (No live rounds or HE in Yellow when live HRB is less than 100%)	M203 inert practice rounds (No live rounds or HE in Yellow when live HRB is less than 100%)
		100% and higher	M203 inert practice rounds (No live rounds or HE in Yellow)	M203 inert practice rounds (No live rounds or HE in Yellow)	40mm grenade M79 and M203: OK in Yellow only when live HRB fuel moisture 100% or	40mm grenade M79 and M203: OK in Yellow only when live HRB fuel moisture 100% or	40mm grenade M79 and M203: OK in Yellow only when live HRB fuel moisture 100% or
	MK19 Grenade Launcher/Mach. Gun	60% and higher	40mm inert round (M385A1) w/ detatching	40mm inert round (M385A1) w/ detatching	40mm inert round (M385A1) w/ detatching	40mm inert round (M385A1) w/ detatching	40mm inert round (M385A1) w/ detatching
		100% and higher			40mm grenade, smoke grenades launched	40mm grenade, smoke grenades launched	40mm grenade, smoke grenades launched
Mines	Mines	60% and higher	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank
		100% and higher	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank	M18A1/A2 Claymore Antipersonnel, Volcano delivery device or modular packed mine system (MOPM) delivered, anti-tank
Simulators	Simulators - Designated Locations in South Lobe of Firebreak Road	60% and higher	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator
		100% and higher		Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator	Projectile-ground burst, Booby trap, Smoke Pots, Smoke Generator, Artillery Simulator
Mortars and Artillery	Mortars	60% and higher	60 mm HE mortar, 60 mm SRTA, and 60 mm mortar (inert), 81mm HE, 81 mm TP, 120 mm	60 mm HE mortar, 60 mm SRTA, and 60 mm mortar (inert), 81mm HE, 81 mm TP, 120 mm	60 mm HE mortar, 60 mm SRTA, and 60 mm mortar (inert), 81mm HE, 81 mm TP, 120 mm	60 mm HE mortar, 60 mm SRTA, and 60 mm mortar (inert), 81mm HE, 81 mm TP, 120 mm	60 mm HE mortar, 60 mm SRTA, and 60 mm mortar (inert), 81mm HE, 81 mm TP, 120 mm
		100% and higher	60 mm HE mortar, 60 mm SRTA, and 60 mm mortar (inert), 81mm HE, 81 mm TP, 120 mm HE	60 mm HE mortar, 60 mm SRTA, and 60 mm mortar (inert), 81mm HE, 81 mm TP, 120 mm HE, OK in Yellow only when live herbaceous fuel moisture 100% or higher			
	Artillery / Howitzer	60% and higher	105 mm HE, 155 mm HE	105 mm HE, 155 mm HE	105 mm HE, 155 mm HE	105 mm HE, 155 mm HE	105 mm HE, 155 mm HE
		100% and higher	105 mm HE, 155 mm HE	105 mm HE, 155 mm HE, OK in Yellow only when live herbaceous fuel moisture 100% or			
Anti-tank weapons	AT-4/M136 and SMAW	60% and higher			84 mm HE anti-tank rocket	84 mm HE anti-tank rocket	84 mm HE anti-tank rocket
		100% and higher			84 mm HE anti-tank rocket: OK in Yellow only when live HRB fuel moisture 100% or higher	84 mm HE anti-tank rocket: OK in Yellow only when live HRB fuel moisture 100% or higher	84 mm HE anti-tank rocket: OK in Yellow only when live HRB fuel moisture 100% or higher
	2.75-caliber rocket	100% and higher				2.75-caliber rocket with only MK66 MOD4 rocket motor and no pyrotechnics in warhead, only to be fired by a qualified user (no requalification, recertification, or performance evaluation use at Makua)	2.75-caliber rocket with only MK66 MOD4 rocket motor and no pyrotechnics in warhead, only to be fired by a qualified user (no requalification, recertification, or performance evaluation use at Makua)
	Javelin	100% and higher				Javelin Guided Missile	Javelin Guided Missile
	TOW missile	100% and higher					Inert TOW missiles (concrete warhead)

Cells shaded Green are only permitted for use when Burning Index is 20 or lower.
Cells shaded Yellow are only permitted for use when Burning Index is 47 or lower.
Cells shaded Red are permitted under all fire weather conditions.

In some years, live herbaceous fuel moisture remains above 60 percent year-round. In the drier years on record, live herbaceous fuel moisture was calculated to fall below 60 percent in late June or early July, without recovery until the October green-up period. Makua will be closed to ball ammunition and blanks when live herbaceous fuel moisture at the Makua Range weather station is calculated by the interagency WIMS to fall below 50 percent. In the drier years on record, live herbaceous fuel moisture was calculated to fall below 50 percent between mid July and early September, but remained above 50 percent year-round in wetter years. Weapons that are likely to ignite wildland fires are proposed for use during periods of low fire danger, when the burning index (a fire danger index related to wind speed and relative humidity) is lower.

The assigned Army Wildland Fire Incident Commander and the senior Range Control officer staffing Makua during live-fire training are both responsible for ensuring that all weapons restrictions and fire suppression staffing guidelines are followed. Range Control personnel, the Army Fire Chief, the Army Wildland Fire Management Officer, and the Army Wildland Fire Incident Commander providing fire suppression staffing at Makua all have the duty and responsibility to shut down the range to training activities not in conformance with the restrictions listed in this Project Description. The Army will stop training in Makua and will reinitiate consultation with the Service if the military does not act in conformance with the Army regulations including range safety guidelines and the additional restrictions and guidelines described in this Project Description.

All weapons will be targeted at points within the south lobe of the firebreak road. A limited number of weapons will be fired from the North Firing Point in the north lobe of the firebreak road. The rest of the weapons will be fired from designated areas within the south lobe of the firebreak road. A log of the time and location of each round landing outside the south lobe of the firebreak road will be maintained by the wildland firefighters stationed on the observation tower during live-fire training exercises. A copy of these records will be provided to the Service quarterly.

2.6 Training Scenarios

2.6.1 Combined Arms Live-Fire Maneuver Training

The following scenario describes a typical combined arms live-fire exercise (CALFEX) and is defined by the integration of different arms, such as infantry, aviation, artillery, engineers, and others, to achieve a combined effect on the enemy greater than if each weapon system were used individually. A CALFEX at Makua will be conducted at the platoon or company level and 50 CALFEXs will be conducted each year. Each exercise is carried out over several days and can occur either during the day or night. Nighttime training activities may consist of the same activities that are conducted during the day. Night live-fire training will not occur until after fire suppression issues have been finalized by the Army and approved by the Service. Table PD 3 presents the estimated quantities of ammunition to be used by the Army for 50 company-level CALFEXs. A typical company-level CALFEX would include a maneuver ground force of dismounts with small arms weapons (M4, M16A1/A2, M249 SAW, M240B machine gun, M203 grenade launcher). Table PD 2 presents the small arms and other weapons that could be used during a typical CALFEX. If the Army proposes incorporation of a weapon not listed on Table PD 2, then the Service will review the weapon request prior to use at Makua to ensure that its use

Table PD 3. Estimate of Munitions to be Expended at Makua during CALFEXs.

Weapons System	One Daytime and Nighttime CALFEX (Assuming Night-Time Live-Fire Training)	50 CALFEXS' (Assuming Year-Round Training)	Estimated Average Months of Training per Year (Based on Live Herbaceous Fuel Moisture Restrictions)	Estimated Number of Years of Weapons System Use (Based on Endangered Species Expedited Stabilization and Fuelbreak Construction Requirements)	Estimated Total Number of Rounds to be Fired in 30 Year Life of Biological Opinion (Assuming Night Live-Fire Training)
M24 sniper weapon 7.62 mm rifle	17	850	11.2 months/year	30 years	5,712
9 mm pistol	0	0	11.2 months/year	30 years	0
M249 SAW 5.56 mm machine gun	6,120	306,000	11.2 months/year	30 years	2,056,320
M 16A2 5.56 mm rifle	20,196	1,009,800	11.2 months/year	30 years	6,785,856
M4/M4A 1 5.56 mm machine gun	4,692	234,600	11.2 months/year	30 years	1,576,512
M240B 7.62 mm machine gun	2,040	102,000	11.2 months/year	30 years	685,440
M2 .50-caliber machine gun	170	8,500	11.2 months/year	30 years	57,120
M1 tracer	Unknown	Unknown	6 months/year	15 years	Unknown
MK 19 40 mm machine gun	68	3,400	9.9 months/year	25 years	16,830
M203 40 mm grenade launcher	388	19,400	9.9 months/year	30 years	115,236
Kiowa helicopter with .50-caliber machine gun	1,360	68,000	11.2 months/year	30 years	456,960
Fragmentation grenades	34	1,700	9.9 months/year	30 years	10,098
Smoke grenades	12	600	9.9 months/year	30 years	3,564
Engineer support with Bangalore torpedo	3	150	9.9 months/year	30 years	891
MI 8A1/A2 Claymore mine	9	450	9.9 months/year	30 years	2,673
2 lbs. C4	3	150	9.9 months/year	30 years	891
Shape charge, 40 lbs. C4	Not applicable	36	9.9 months/year	30 years	214
Shape charge, 15 lbs. C4	Not applicable	80	9.9 months/year	30 years	475
Cratering charges	Not applicable	24	9.9 months/year	30 years	143
60 mm mortar (inert)	46	2,300	9.9 months/year	30 years	13,662
60 mm HE mortar	37	1,850	9.9 months/year	30 years	10,989
81 mm HE mortar	49	2,450	9.9 months/year	30 years	14,553
120 mm HE mortar4	Unknown	Unknown	9.9 months/year	30 years	Unknown
M19, 105 mm HE howitzer	121	2,420	9.9 months/year	30 years	35,937
155 mm HE howitzer3	324	9,720	9.9 months/year	30 years	96,228
AT-4/M 136, SMAW: 84 mm anti-tank rockets	3	150	6 months/year	25 years	450
2.75-caliber rockets	56	2,800	6 months/year	15 years	5,040
Javelin	2	100	6 months/year	15 years	180
Inert TOW missiles	2	100	6 months/year	May be zero years	May be zero

[1]Each company-level CALFEX includes both a daytime and nighttime iteration. Estimate of munitions is based on actual training data. Nighttime live-fire training will not occur unless nighttime helicopter fire suppression is authorized.

[2]Some of the M 16A2 rounds are SRTA rounds.

[3]For CALFEXs at Makua, the 155 mm howitzer and the 105 mm howitzer are interchangeable weapons. Both weapons will not be used during the same CALFEX. The number of rounds presented for 50 CALFEXs is the estimated maximum number of rounds to be expended during a training year. Summer CALFEXs will often not include all weapons due to live herbaceous fuel moisture limitations.

[4] Although the 120 mm HE mortar is planned for future use at Makua, no allocations for the weapon have been made at this time.

[5] The ammunition expenditures presented in this table represent a typical company-level CALFEX. The actual expenditures for an individual CALFEX or training year will fluctuate and can be higher or lower than the numbers in this table. Also, for an individual CALFEX, additional rounds of a smaller caliber mortar or artillery weapon may be substituted for the estimated rounds of a larger weapon; the total number of rounds for the smaller weapon will not exceed the combined estimated rounds for both weapons. For example, additional rounds of the 60 mm HE mortar can be fired if the 81mm HE mortar is not used during a given exercise, but the total number of 60 mm rounds fired during that exercise will not exceed 86 (49 + 37).

is compatible with the specifications in this Biological Opinion. Indirect fire and aviation units will support troop units conducting a typical CALFEX. Indirect fire support would include the company and battalion mortars (two 60 mm mortars, two 81 mm mortars, and the 120 mm mortar), as well as the platoon 105 mm artillery (three howitzers); 155 mm howitzers would be used interchangeably with the 105 mm weapons. Vehicles and aircraft that would be used during training include the following: up to six Humvees used on existing roads, 2.5-ton or 5-ton cargo trucks (two), UH-60 Blackhawk helicopters (up to six), OH-58D Kiowa Warrior helicopters (up to three), CH-47 Chinook helicopters (two), Strykers (up to five), any wheeled vehicle in the Army inventory, and Unmanned Aerial Vehicles.

Training units arrive at Makua and bivouac in designated areas near the road. Their ammunition is stored at the ammunition supply points in the vicinity of the exercise and is guarded throughout the exercise. Soldiers subsist on packaged meals-ready-to-eat or delivered hot foods, and they use portable toilets. Planning and instruction generally lasts two days. Unit personnel practice their exercise without live fire and conduct other tasks associated with preparing for the actual live-fire exercise. Pop-up targets and blast simulators are sometimes placed in the training area to replicate enemy contact.

Unit leaders (captains, lieutenants, and sergeants) receive briefings from the 25th ID G3 Training, Range Division and from USAG-HI DPW Environmental Division staff on the locations of threatened and endangered species and habitat, locations of known cultural resource sites, fire hazards, and fire prevention measures and procedures. Where necessary, the scenario is modified to reduce the risk of fire and other damage to the environment. The unit leaders then brief every Soldier in the unit on the importance of protecting endangered species and habitat, cultural sites, and preventing wildfires.

On days three and four, unit personnel conduct their actual training exercise. On day three, only blank ammunition is fired, and mortars and artillery are aligned, calibrated, and fired. Training exercises conducted on both days typically last approximately three hours and begin at dawn. The company generally moves with three platoons of approximately 30 to 40 Soldiers (or nine squads of five to 10 Soldiers, plus personnel operating machine guns and support personnel) toward the objectives. Soldiers in the lead platoon fire their rifles and machine guns at the objective or target. The mortar section fires 60 mm mortars at the objective, while the lead platoon moves toward it. When the lead platoon makes contact with the objective, the platoon leader moves squads to a position of advantage and, by spreading out Soldiers to ensure they can hit every target, gains fire superiority over the “enemy.”

Most exercises present advancing platoons with the problem of trench lines, mine fields (simulated), and concertina-wire obstacles. Confronted with these situations, platoons must practice the skills required to enter and clear a trench line, to conduct a company deliberate attack, to conduct a platoon and squad attack, to knock out a bunker, and to conduct an initial breach of a mine field/obstacle. Some simulated minefields will be cleared with the aid of engineers attached to the company. Bangalore torpedoes may be used to blast routes through such locations. Objective Deer is used to teach some of these primary tasks. The lead platoon guards the objective with machine guns while two other platoons advance toward Objective Deer via a creek bed. A simulated minefield and a concertina-wire obstacle usually protect the westernmost entrance. The company commander will order the engineer squad to reduce the obstacle with a bangalore torpedo designed to focus the blast in a cutting line that explodes mines, cuts wire, and allows Soldiers to walk over the site. Several bangalore torpedoes may be combined to clear a wider path.

After the minefield and wire obstacle have been cleared, the Soldiers run through the breach to the trench complex. Two Soldiers move into the trench and fire down its length to engage any enemy present. The squads and platoon follow, and as each lead Soldier comes to a turn in the trench line, other Soldiers provide shield. The unit Soldiers continue down the trench to the first bunker or room, where four-person fire teams clear the bunkers with fragmentation hand grenades. The lead Soldier guards the opposite approach, and the remaining three Soldiers position themselves close to the door in a "stack." The lead Soldier tosses a grenade in, and the three Soldiers rush the room following detonation, pointing their rifles at different prearranged locations in the bunker, covering any "enemy" remaining. Soldiers continue clearing the trench in this manner.

Upon seizing their objectives, units must prepare for any counterattack. A company commander may direct the emplacement of claymore mines (small, command-detonated antipersonnel mines) in front of the unit. If artillery is employed in the scenario, the company commander may distribute its fire in advance of an attack or direct its fire toward a target to suppress counterattack. The commander may also direct the company's anti-armor section to position its missile launchers to prevent any enemy tanks from overrunning the just-taken objective (e.g., the trench line). Once the enemy counterattacks and is repelled by the company, the exercise is over.

At the end of a CALFEX training, units remove any target equipment they may have provided, gather brass casings from spent rounds, remove litter, and otherwise make every effort to restore the range to its condition prior to their use. Explosive ordnance disposal specialists will destroy all identified unexploded ordnance. Ordnance normally is destroyed where it is found, whether it resulted from the training being conducted or from earlier exercises. Unexploded rounds are removed or destroyed at the conclusion of a training exercise.

These procedures are designed to ensure that training conducted at Makua will not increase the amount of unexploded ordnance on the site and may reduce it, if possible. Occasionally, the explosive ordnance disposal specialists are not available to dispose of unexploded ordnance immediately after a training exercise. In this case, unexploded ordnance will be disposed of once the specialists are available and prior to use of the area for new training. Excess propellant charges from mortars and artillery is burned in a burn pan in the open field south of the helipads. Any ash generated from powder burn operations is removed from the burn pan and collected in a

208-liter (55-gallon) drum. When the drum is full, the ash is tested to determine if it meets Environmental Protection Agency criteria as a hazardous waste. The ash is ultimately removed from the site and is disposed of in accordance with Environmental Protection Agency regulations.

The company-level CALFEX is the maximum level of training proposed at Makua due to the range's limited suitable maneuver training land. To minimize the potential for wildfires, various portions of CALFEXs and other live-fire training will only be conducted during Green or Yellow fire danger rating periods, pursuant to restrictions in Table PD 2 weapons table. CALFEXs conducted at Makua will not include aerial bombardment (dropping bombs from aircraft), use of tracked armored vehicles, or training on Makua Beach.

2.6.2 Live-Fire Training

Live-fire training includes basic weapons marksmanship ranges, grenade training, urban/village assault and entrenched enemy training, small unit live fire and maneuvers, artillery and mortar firing, infantry demolition training, and use of mines and bangalore torpedoes. Live fire normally entails an individual gunner, a crew of a weapon system, or a collective unit firing at predetermined targets from designated firing positions on a range facility. The individual Soldier qualifies with an assigned weapon and then progresses through squad, platoon, and company-level live-fire exercises. The requirement for live-fire training varies depending on individual and unit mission, weapons assigned, and ammunition available. Each Soldier must demonstrate proficiency on the assigned weapon system once or twice per year. Unit Commanders must ensure that live-fire training meets readiness standards. Weapons proficiency, or qualification, is scored and recorded for each individual or crew and is reported collectively by unit. No live-fire training takes place outside of established ranges or surface danger zones. The firing of blank ammunition, including blank munitions up to .50-caliber, is not considered live fire. However, because hot casings and residues related with the firing of blanks have the potential to ignite wildland fires, Makua will be staffed with ground and helicopter firefighting resources in accordance with the staffing guide when blanks are being fired.

Live-fire exercises require several iterations of training. The ultimate goal of each live-fire exercise, regardless of unit size, is to execute the exercise at night, under limited visibility. A unit conducting a live-fire exercise will initially rehearse its action by conducting a dry walk-through with no ammunition (first iteration). It will then conduct a full-speed exercise using blank ammunition (second iteration). Providing this is done to standard, the unit then will execute a daytime live-fire exercise (third iteration). Nighttime live-fire exercises add a new dimension to the battlefield and require additional iterations. In general, after a unit has successfully completed daytime live-fire exercises, it will conduct a nighttime blank fire rehearsal (fourth iteration), before finally culminating in a nighttime live-fire exercise (fifth iteration). While this describes a five-day scenario, the Army can compress the schedule in various ways. Due to the current limitations on munitions and fire suppression aircraft safety considerations at Makua, units do not currently conduct nighttime live-fire exercises; however, nighttime live-fire exercises are essential in ensuring that units are combat ready. Nighttime live-fire training will only be conducted after night-flying fire suppression helicopter staffing guidelines have been developed by the Army and approved by the Service.

2.7 Military Operations on Urbanized Terrain

Military operations on urbanized terrain training occurs on Objective Deer and provides troops with the opportunity to train in a realistic urban environment (e.g., using bunkers and other man-made structures) and to experience as much realistic stress as possible. Training may include limited use of short-range training ammunition, which uses a plastic ball projectile. Although short-range training ammunition is classified for live-fire training in accordance with AR 385-63, the maximum range of this ammunition is only 275 to 640 m (879 to 2,247 ft), depending on the caliber used. Short-range training ammunition may be used at Makua in conjunction with other live-fire ammunition.

2.8 Bivouac

Bivouac consists of setting up camp for rest, re-supply, maintenance, or to provide support. Bivouac sites vary depending on unit size and mission. The size of bivouac areas can range from 100 by 100 m (330 by 330 ft) for a squad (9 Soldiers) or platoon (35 Soldiers) to 300 by 300 m (984 by 984 ft) for a company size (120 Soldiers) bivouac. Depending on unit size, bivouac sites can contain a vehicle and weapons maintenance area, vehicle parking area, general supply area, munitions supply area, medical area, helicopter landing zones, and vehicle off-loading area. A bivouac site may consist of a series of tents, temporary structures, and equipment covered with camouflage nets. Bivouac is normally done on level or gently rolling areas that provide vehicle and/or aircraft access. Open fires are not allowed during bivouac, but cooking in special mobile kitchens (enclosed ovens) and use of tent heaters (enclosed) and generators is permitted. Munitions used in bivouac typically consist of grenade and artillery simulators and blank ammunition.

2.9 Sniper Training

Sniper training includes the use of a M24 sniper rifle and firing a 7.62 mm round at targets up to 1,000 m (3,281 ft) away. The M107 heavy sniper rifle that fires .50-caliber ammunition may also be used. Snipers frequently participate in CALFEXs at Makua. For stationary target practice, snipers would position themselves near Range Control while shooting toward targets in the south impact area.

2.10 Restrictions

No tracer ammunition will be used by snipers.

2.11 Air Assault and Aviation Support

When air assault is part of a CALFEX, Soldiers board helicopters and fly to the approved landing zones at Makua. The helicopters land, discharge their loads and fly off. Some vehicles and equipment may be rigged for external transport beneath the helicopters (a practice known as sling-loading), allowing the aircraft to transport both the Soldiers and their equipment to a given location at the same time.

During CALFEXs, OH58 (Kiowas), UH60 (Blackhawks), and CH47 (Chinooks) are used. The exercise typically involves two or three OH58s (two for firing and one for command and control). During the exercise, there is typically a ground rehearsal, a fly-by rehearsal, and then the actual close-air support firing exercise with the regular .50-caliber M-2 rounds. Over the five-day CALFEX, there will be up to five helicopter approaches during the non-live-fire day and up to five approaches during each of the daytime and nighttime live-fire iterations. In addition, two CH-47 Chinook helicopters will transport troops and equipment from Schofield Barracks to Makua. Fire suppression helicopters will also be assigned to Makua in accordance with the helicopter staffing guidelines specified in this Project Description. The command and control helicopter typically flies orbits (to conserve fuel) over the ocean at 600 m (2,000 ft) above sea level. Its distance from shore ranges from approximately 0.4 kilometers (km) (0.25 mi) up to 1.6 km (1 mi) offshore. At no time do they go beyond the jurisdictional waters of the United States.

2.12 Stryker Infantry Carrier Vehicle

The Stryker is a wheeled vehicle with a 350-horsepower engine and a weight of 19 to 20 tons. Up to five Strykers will operate primarily from stationary positions and only on existing roads or paved areas at Makua. There will be no off-road use of Strykers at Makua. Strykers will be used to fire MK 19 (40 mm), .50-caliber machine guns, and 120 mm mortars from the road into the impact area. Strykers also will be used as command and control vehicles. Potential use of Makua by Stryker Brigade Combat Team forces includes approximately six to nine annual company-level CALFEXs with some squad and platoon maneuver live-fire or non-live-fire training. Stryker vehicles will shoot at targets in Objective Deer, from interior roadways in the vicinity of Objective Coyote.

2.13 Unmanned Aerial Vehicles

The Shadow 200 is similar to a large radio-controlled model airplane. The aircraft weighs approximately 147 kilograms (kg) (325 pounds (lbs)), has a wingspan of 4 m (13 ft), and measures 3.4 m (11 ft) from nose to tail. It is a remote-controlled, gas-powered vehicle. Each system includes three unpiloted aircraft equipped with imagery sensors, a ground transport vehicle, two ground control stations mounted on vehicles, and launch, recovery, and support equipment pulled on trailers. Following the mission, it can be recovered in a small area with parachute deployment at low altitude. Recovery can be accomplished manually or with an optional auto recovery system, during which an air bag is deployed prior to touchdown to cushion the landing and protect the vehicle and payload. Unmanned aerial vehicles will only be launched and recovered in restricted or Class D airspace, which includes Makua Valley. The unmanned aerial vehicles will be used for up to nine hours each week, either during training exercises or independently. Unmanned aerial vehicles may take off at Makua and fly over the Makua action area without on-site or standby wildland fire suppression staffing. Unmanned aerial vehicles will not land in any area outside the south lobe of the firebreak road at Makua. Unmanned aerial vehicles may take off and land at Dillingham or Wheeler Army Airfield without fire suppression staffing.

2.14 Convoy Training

The Army uses convoy training to simulate ambushes and other enemy attacks on vehicle convoys. Convoy training will have effects similar to the CALFEX.

2.15 Standard Operating Procedures (SOPs)

The SOPs outline training precautions and fire minimization and suppression procedures that will be followed by Range personnel and Soldiers at Makua. They also provide procedures to protect biological and archaeological resources. No training will occur at Makua until the Service has determined that Range SOPs adequately reflect the updated weapons restrictions and fire suppression staffing requirements of this Biological Opinion. The following items in the SOPs are of particular importance in the protection of biological resources.

1) The unit's timeline schedule may be curtailed due to training restrictions being imposed as a result of unfavorable fire danger ratings.
2) All emergency (accidents, incidents and fires) will be immediately reported to Range Control.
3) Targets will not be moved or altered in any way. Special target requests will be coordinated at least four weeks prior to the first day of training.
4) Fire prevention/endangered species/cultural resource briefings have been completed.
5) The commander will use the Risk Management Process to identify hazards, assess hazards, make risk decisions, implement controls and supervise the action.
6) The commander judges the risks associated with the selected scenario and determines any prudent actions taken or modifications to the exercise.
7) All weapons systems will be addressed in the risk assessment.
8) The written Risk Assessment Process will continue to be updated during the planning, and coordination sequence. However, the process of assessing risks will continue during all phases of a live-fire training scenarios. Leaders will maintain current copy of the risk assessment during training.
9) All firers have a clear field of fire to the target. Firing will only be at designated observable targets.
10) Firing is stopped promptly when an unsafe act is observed/reported or when a round impacts outside the fire access road. Anyone can call cease-fire on a range for any safety concern.
11) If a fire starts, immediately cease training and follow fire suppression procedures as set forth in Annex A of the SOP.
12) Smoke grenades will only be used in areas cleared of debris/grass and will be placed in metal containers. Units are required to place grenades in metal pails or barrels provided by Range Control.
13) All incidents, accidents, fires, rounds fired out of impact or ammunition problems are immediately reported to Range Control.
14) The provisions outlined in the SOP are applicable to all fire managers, resource managers, range supervisors and range safety technicians, unit commanders, and all military personnel that utilize Makua for training, maintenance and other purposes. All other personnel entering Makua will be familiar with the contents of the SOPs. Deviation

from the SOPs is unauthorized except by direct orders of the Commander, 25th Infantry Division (L) and Commander, USARHAW, in consultation with the Service.

15) The prevention of range fires is the responsibility of every Soldier, contractor, and civil servant working and training at Makua.
16) Army personnel need to minimize fires from starting.
17) Army personnel must quickly and safely extinguish fires by following the fire suppression procedures.
18) Army personnel must stay within the perimeter firebreak roads except when directed to conduct work outside the firebreak roads to conduct fire suppression work. There are dangers of unexploded ordnance and biologically significant areas and management units outside of the roads. If entry outside of the perimeter firebreak roads is absolutely necessary during training, coordinate through the 25th Infantry Division (L), USARHAW, G3, Range Division, Hawaii, to obtain approval.
19) All units will wash their vehicles prior to entering Makua. Additionally, Soldiers will clean their boots and personal gear of mud and or pests, brought from outside Makua, at the entrance to Makua prior to moving onto the range.

3. Wildland Fire Suppression and Fuels Management

The Integrated Wildland Fire Management Plan (2003a) was developed to reduce the risk and impact of wildland fires by limiting their occurrence, size, and severity while still providing for military training on all Army installations in Hawaii. The plan details fuels management, use of prescribed fire, training, fire prevention, and fire suppression response on Army lands. Throughout this consultation, the Service and the Army referred to the Wildland Fire Management Plan (2003), the fire history at Makua (Beavers et al 1999), recommendations by Beavers for fuel treatments (Beavers 2006, 2007a), Army After Action Reviews, and interviews with local fire management experts in order to develop an updated fire protection system for Makua. The updates primarily include refinement of weapons restrictions, improved reliability of fire danger calculations, new and improved fuelbreaks and firebreaks, and refined fire suppression helicopter staffing requirements.

Activities with highest risk of igniting fires outside the firebreak road are restricted to periods when the grass fuels within the valley are greener and burn more slowly. Weapons more likely to ignite wildland fires are further restricted to periods of the day when wind speeds are lower and relative humidity is higher, when the grass fuels are less likely to ignite, and when fires will be easier to suppress. New fuelbreaks and firebreaks, and improved firefighter preplanning will provide for greater protection for the Kahanahaiki, Kaluakauila, and Ohikilolo management units in the event of a large fire. A staffing guide has been developed to ensure that adequate fire suppression resources are assigned to each live-fire training exercise at Makua. Staffing requirements vary by time of year and weapon system in use, in order to ensure that more suppression force is available during dry months or when the weapons being used are likely to ignite fires outside the firebreak road. Whenever a weapon or demolition is fired, Makua will be staffed, at minimum, by five National Wildlife Coordinating Group (NWCG)-qualified, pack tested, red carded wildland fire personnel with two Type 6 engines and one water tender. Aerial fire suppression resources will be assigned to exercises in accordance with helicopter staffing guidelines, which are dependent on live herbaceous fuel moisture, forecasted wind speed and direction, and weapons system in use. More substantial fire suppression helicopter capability is assigned when grass is more cured, when wind speeds are higher, and when weapons with a higher risk of igniting fires are in use. In the event of a fire at any location, training is stopped immediately and the unit takes all appropriate actions to put out the fire.

The revised Makua Standard Operating Procedures section in the Wildland Fire Management Plan will outline the Fire Danger Rating System, revised weapons restrictions, new NWCG qualifications standards and helicopter staffing requirements, fire equipment requirements, new firebreak and fuelbreak installation and maintenance standards, fire reporting responsibilities, and fire prevention, detection and suppression standards, which will minimize the risk of resource damage due to training-related wildland fires at Makua, as summarized in this Project Description. The Standard Operating Procedures will also detail the fire prevention briefings that will be given to range users prior to commencement of training, notification lists in case of fire, operational decision charts for fires, and maps of endangered species, critical habitat, fuels, firebreaks, fuelbreaks, and vegetation. The portions of the Wildland Fire Management Plan pertaining to Makua, including the changes to the plan that resulted from this consultation, will be fully funded by the Army. The Standard Operating Procedures section of the Wildland Fire Management Plan and the range Standard Operating Procedures are currently being revised to fully incorporate all of the training, staffing, fire weather, weapons restrictions, and reporting requirements outlined in this Project Description.

3.1 Firebreaks and Fuelbreaks

Firebreaks and fuelbreaks have been designed to reduce the risk of fire spreading outside the south lobe of the firebreak road and to further protect exposed management units and areas of designated critical habitat. The north and south lobes of the training area are surrounded by a firebreak road, maintained as a passable road, cleared to bare mineral soil to a width of 6 m (20 ft). Fuelbreaks are swaths of less flammable vegetation, where fuel load or continuity is manipulated mechanically, or with prescribed fire, grazing, herbicide, or other means in order to stop or slow fire spread. The dimensions and maintenance schedule of each of the fuel treatment areas will vary due to accessibility, unexploded ordinance, topography, and vegetation response. Grass inside the southern lobe of the firebreak road is maintained to stubble height in Objectives Badger, Buffalo, Coyote, Deeds, Deer, Elk, and Wolf, where most weapons are targeted, and all flammable material is cleared from firing points and detonation areas pursuant to DA PAM 385-63 (2003, as updated).

New fuelbreak and firebreak specifications have been developed for several of the Makua Implementation Plan management units (Kaluakauila, Kahanahaiki, Pahole, Upper Kapuna, West Makaleha, Ohikilolo, and Lower Ohikilolo). With the exception of Lower Ohikilolo, which will be protected prior to the use of any weapon or prescribed fire at Makua, the new fire protection systems will be operational within five years or prior to the implementation of Column C in the Weapons Restrictions Table (see Table PD 2), whichever occurs earlier. Because mowing or aerial herbicide treatment is expected to produce a thick layer of dead grass that will take several years to decompose, aerial herbicide and mowing treatments will begin no later than two years after the completion of this Biological Opinion in order to ensure that the fuelbreak is operational within five years. Fuelbreak and firebreak construction will not detract from implementation of the Makua Implementation Plan. It is anticipated that the wildland fire crew or contractors will be utilized to complete the fuel treatments that are farther than 3 m (10 ft) from endangered plants. Tracers, MK19, AT-4, SMAW, 2.75-caliber rocket, Javelin, and TOW will not be used at Makua unless the Kaluakauila, Kahanahaiki, Pahole, Upper Kapuna, West Makaleha, Ohikilolo, and Lower Ohikilolo fuelbreaks and firebreaks are completed and/or maintained as detailed in this Project Description. If, after five years from the date of this document, the fire protection systems are not completely installed and adequately maintained, use of all devices on Table PD 2, and prescribed burning at Makua will be suspended until the systems can be brought up to standard.

3.1.1 Fuel Treatments in South Lobe of Firebreak Road

Prior to implementation of Table PD 2, Columns B through E, the grass along a 60 m (197 ft) strip of vegetation just inside the south lobe of the firebreak road will be maintained at 30 cm (1 ft) height or less by mowing, grazing or other fuel manipulation, such as frequent herbicide treatments in conjunction with prescribed burning (Figure PD 6). This treatment will expand existing grass treatment areas within the south lobe of the firebreak road by 17 ha (43 ac). This fuelbreak, in conjunction with the existing 6 m (20 ft) mineral soil firebreak road, will provide ground fire suppression forces an area where they can more easily conduct burnouts or attack fires directly as they near the road. The spread of a large fire inside the south lobe of the firebreak road will be effectively halted, and the width of vegetation clearing is adequate to prevent the majority of spot fires from crossing the firebreak road, limiting the number of spot fire ignitions outside the impact area.

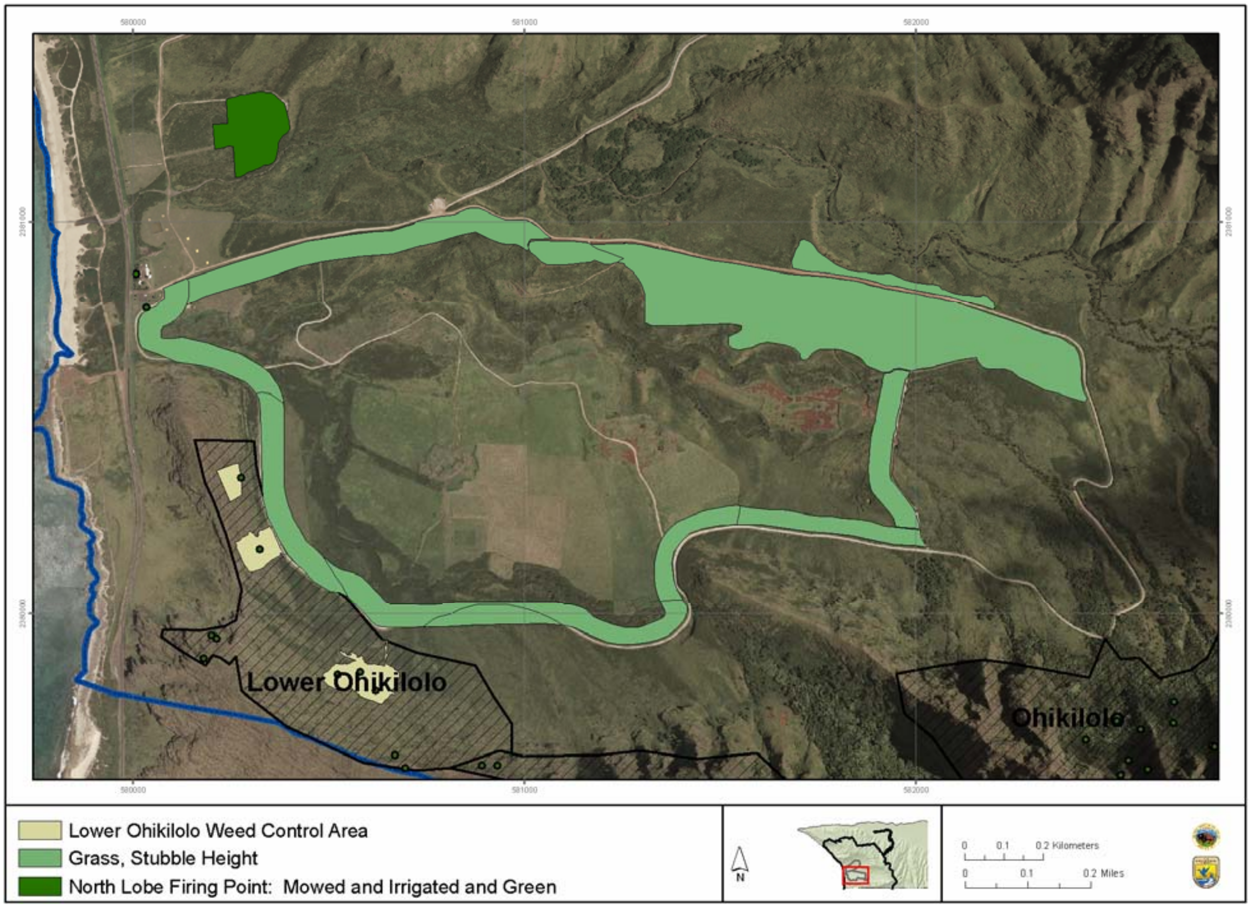


Figure PD 6. Minimum areas to be treated prior to implementation of Column B weapons restrictions and reduced on-site helicopter staffing for limited weapons.

3.1.2 Fuel Treatments in Lower Ohikilolo Management Unit

Within the Lower Ohikilolo Management Unit, all standing live and dead grass will be removed from within 2 m (6.6 ft) of all Makua Implementation Plan stabilization plants, and grass will be controlled with herbicide utilizing an adaptive management approach within the 3 ha (7 ac) weed control areas identified in the Makua Implementation Plan and shown in Figure PD 6. The objective is that the fuel within the weed control area will not support the spread of fire given winds less than 15 mph and one-hour fuel moisture of eight percent or higher. Cliff areas that are too steep to access will be excluded from treatments. Grass removal within 2 m (6.6 ft) of all stabilization plants will be completed prior to the use of any device listed in Table PD 2 and prior to any prescribed burning at Makua. Successful completion will be achieved when grass provides less than one percent cover within 2 m (6.6 ft) of all endangered plants. Fuel manipulation within the weed control area will be achieved through an adaptive management approach.

3.1.3 Fuel Treatments Protecting Pahole, Upper Kapuna, and West Makaleha

Eighty percent of the C-Ridge and East Rim management unit perimeters are protected by intact shrub and forest vegetation that is 200 m (656 ft) wide. Depending on fuel moisture conditions and the species composition of shrub or forest vegetation, fire rate of spread is between four and 400 percent slower in the shrub/forest than it is in the grass covered areas. The shrub/forest vegetation on the slopes of the valley serve as a shaded fuelbreak, slowing fires so that fire suppression helicopters can contain them before they reach the management units. If small portions of this shaded fuelbreak area are burned, the Army will restore shrub vegetation to the burned portions of the fuelbreak and control grass in the burned areas so that grass cover does not exceed 20 percent in any square meter on the burned area. If larger areas of the shaded fuelbreak are burned, the Army will either restore shrub cover and control the grass on the burned area or install and maintain a strategic firebreak sufficient to halt the spread of fire into the management unit.

3.1.4 Fuel Treatments to be Completed Within Five Years or Prior to Implementation of Column C Weapons Restrictions

Within five years of the completion of this Biological Opinion, or prior to implementation of Column C weapons restrictions, additional fuelbreaks and firebreaks will be developed and maintained in order to afford additional protection to endangered species and critical habitats in the Kahanahakiki, Kaluakauila, and Ohikilolo management units. To the extent possible, the specifications for these fuel modifications are outlined in this Project Description. Fuelbreak placement or maintenance methodologies may be updated as new techniques are developed through research or as skills are developed through the adaptive management process. Modifications to fuelbreaks and firebreaks that provide protection equal to or greater than the protection afforded by the fuelbreaks and firebreaks proposed in this Project Description may be substituted for those provided in this Biological Opinion with the Service's concurrence. The Army will coordinate with the Service before altering fuelbreak or firebreak design or implementation protocols.

3.1.4.1 Kahanahaiki Management Unit

At the northwest corner of the Kahanahaiki Management Unit, near the Makua Ridge weather station, one of three alternative fire protection systems (Figure PD 7) will be established and maintained in working condition in order for Column C through E weapons restrictions to be applied at Makua. Four of the fires that escaped initial attack at Makua burned into the Kahanahaiki Management Unit at this location (1970, 1984, 1995, and 2003), converting the native shrub vegetation to grass. The area is on a south aspect with an average slope of 100 percent, and it is currently primarily grass-covered.

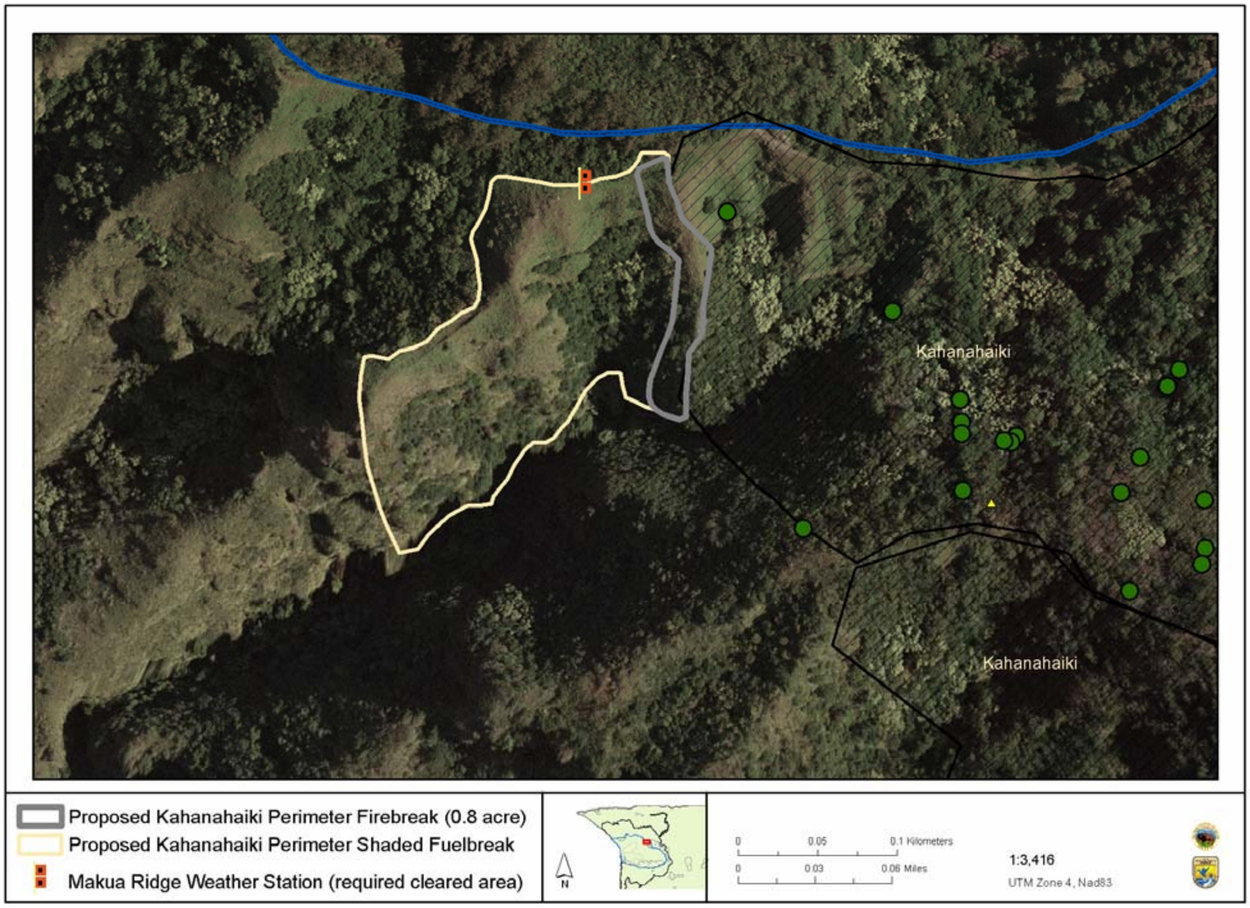


Figure PD 7. Kahanahaiki Management Unit firebreak and fuelbreak alternative treatment areas designed to prevent fires from continuing to breech the northern management unit perimeter.

The three alternative fire protection systems intended to prevent future fires from burning into this area of Kahanahaiki are:

1) A new 150-m long, 20-m wide, 0.3 ha (0.8 ac) firebreak will be established and maintained. The new firebreak will run along the outside of existing management unit perimeter fence line. The firebreak would be kept free (less than one percent cover) of live and dead grass and shrub fuels. The firebreak will be maintained with one or more methods, which may include herbicide, hand tools, shade fabric, or permanent barrier installation.

2) A new sprinkler system will be installed to deliver a spray of water to the 150-m long, 20-m wide (0.3 ha (0.8 ac) area running along the outside of the Kahanahaiki Management Unit fence line. The sprinkler system would be activated when the site is threatened by fire and would provide one-half inch of precipitation on the vegetated area per hour.

3) Grass will be controlled, and shrubs and trees will be reestablished on the 3-ha (7.3-ac) area within 200 m of the Kahanahaiki Management Unit perimeter (Figure PD 8) to

create a shaded fuelbreak. Grass cover will be reduced to less than 20 percent cover over each square meter (10.8 square feet) in the shaded fuelbreak.

The rest of the western edge of Kahanahaiki, and the elepaio critical habitat in this area will be protected from future wildfires utlilizing an adaptive management approach. The approach initially selected is the use of aerial herbiciding and shrub seeding to create fuelbreaks to reduce the risk of fire in the management unit area. Two sites, one on the south aspect at the top of C-Ridge and another 40-m (131-ft) wide fuelbreak at the base of steep drainages on the northwest slopes of C-Ridge, were selected for aerial herbicide and shrub seeding treatment. A total of 2.6 ha (5.3 ac) of grass will be treated with aerial herbicide nine times per year. To prevent erosion, the sites will receive aerial seeding with shrub species. The northern site was targeted to prevent fires from spreading rapidly up three main gulches where Oahu elepaio critical habitat and many listed species occur.

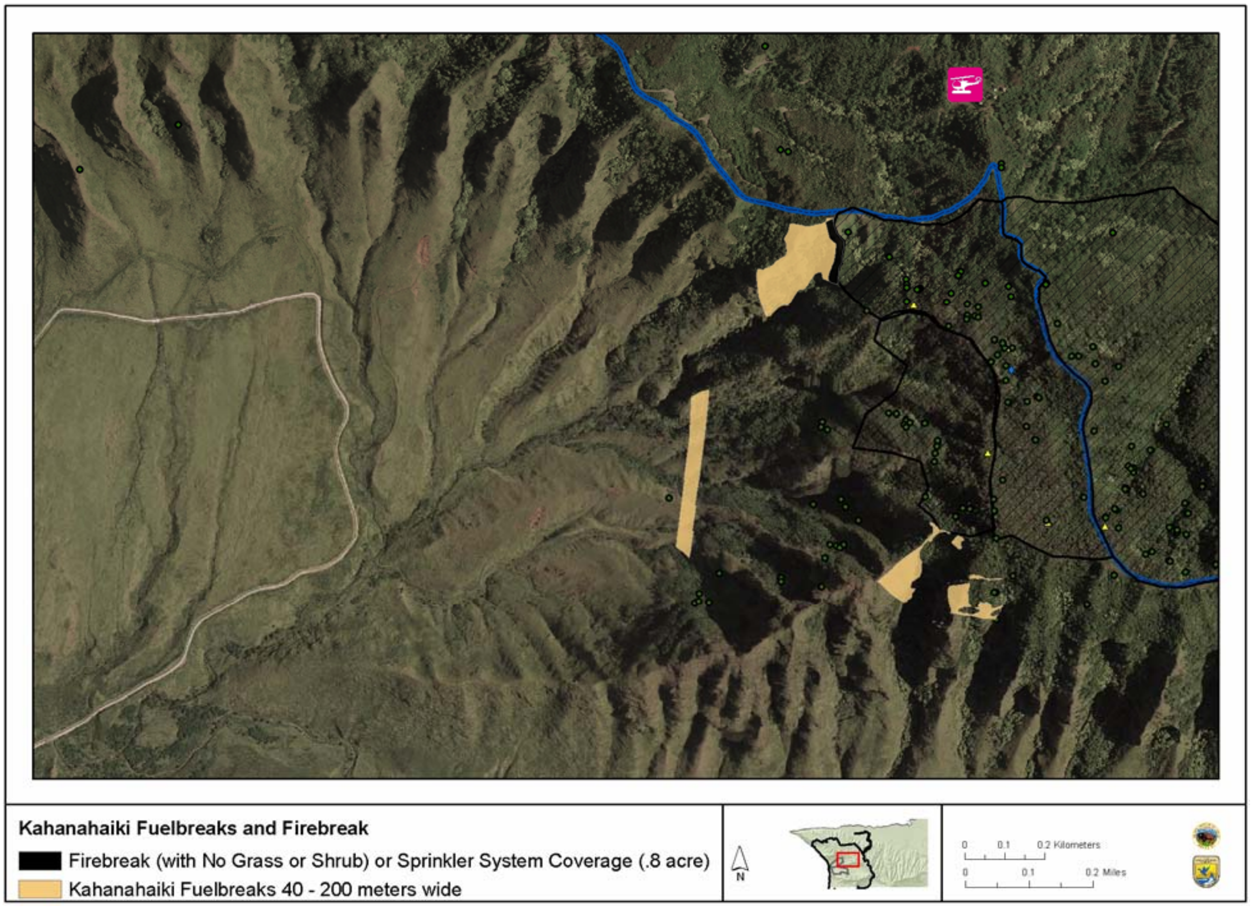


Figure PD 8. Kahanahaiki fuelbreaks and firebreak to reduce fire risk to endangered species and critical habitats from large fires burning outside the firebreak road.

3.1.4.2 Kaluakauila Management Unit and Punapohaku area

A combination of firebreaks and fuelbreaks will protect the Kaluakauila Management Unit. To prevent intense grass fires from burning into the forest, a 6-ha (15-ac), 20-m (66-ft) wide strategic fuelbreak with an integrated firebreak along the southern perimeter of the intact forest vegetation will be established and maintained (Figure PD 9). To be considered adequately completed and maintained, all grass within each square meter of the designated fuelbreak area (see Figure PD 9) within 20 m (66 ft) of the current forest edge must be either less than 30 cm (1-ft) tall or must be less than 20 percent cover. A bare mineral soil firebreak, created with a combination of herbicide and hand tools, of sufficient width to halt the spread of fire in the adjacent fuels, will be integrated into the forest edge fuelbreak. It is anticipated that grass cutting and herbicide work will be conducted throughout the years following the completion of this Biological Opinion so that within five years, the current load of grass fuels is decomposed and the fuelbreak will be operational. The Army is currently seeking funding to restore the grass areas between the ridge and the forest to shrub vegetation. If areas of forest are restored, the 20-m (66-ft) wide fuelbreak, with integrated mineral soil firebreak, would be moved southward, so that restored forest areas will be protected by it. Helispots and permanent safety zones will be established and maintained so that during a large fire, the Kaluakauila forest edge fuelbreak will be safe and accessible for the rapid deployment and on-site patrol and staffing by wildland firefighters, including skilled fireline supervisors and red-carded Army Natural Resources Staff.

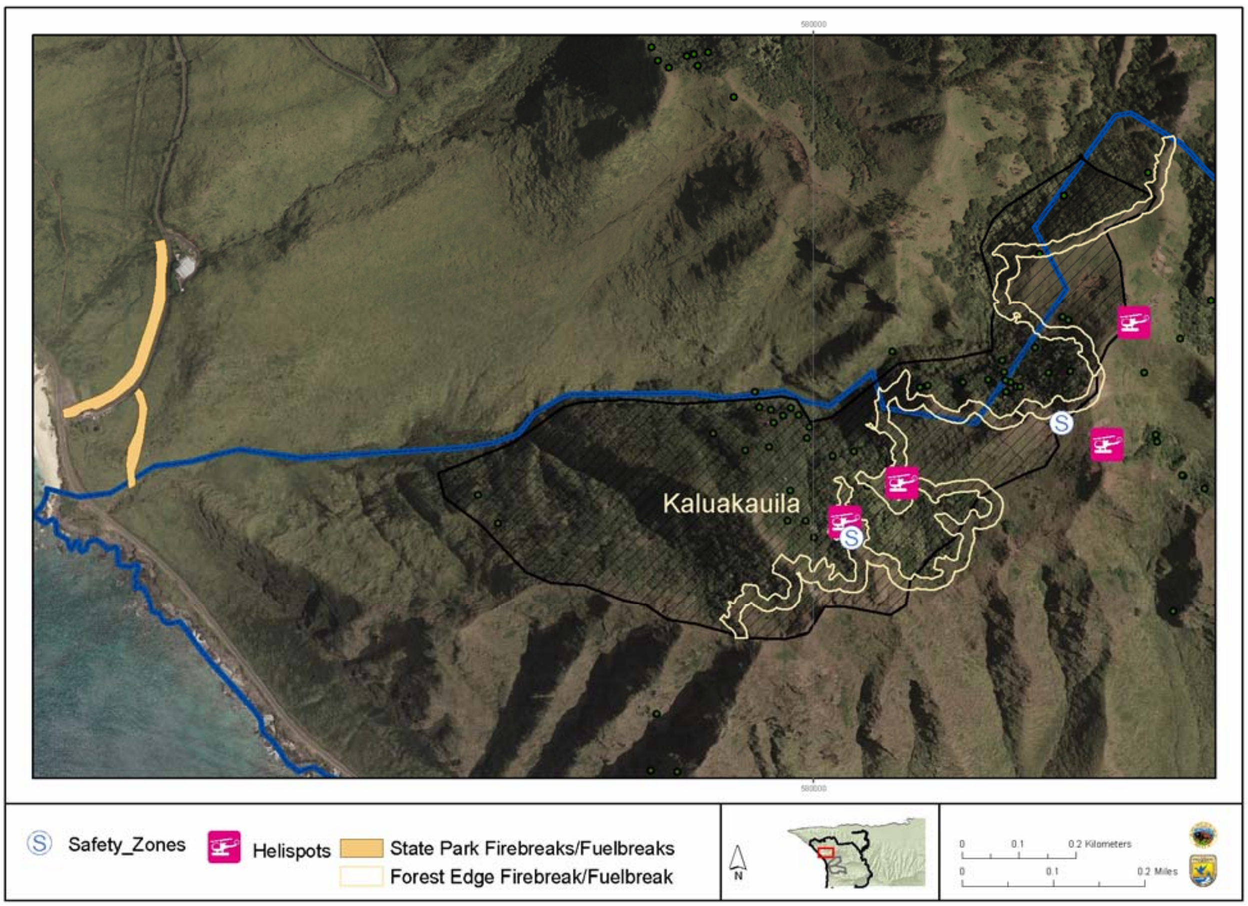


Figure PD 9. Kaluakauila Management Unit fuelbreaks, firebreaks, firefighter's safety zones, and helispots.

An existing road and a historic road on the State land adjacent to the north boundary of Makua will be improved, given approval of the State, to prevent fires ignited in the vicinity of the public beach from burning into the Kaluakauila Management Unit. The historic road area will be improved to provide for fire vehicle passage, and grass control conducted along the lower edge of an existing paved road in the Yokohama vicinity will increase the likelihood that firefighters will be able to prevent beach area fires from burning the Kaluakauila Management Unit (see Figure PD 9).

Within five years of the completion of this Biological Opinion, or prior to implementation of Column C weapons restrictions the Army will select and implement one of three alternative measures to further minimize fire impacts to endangered species occurring within and adjacent to the Kaluakauila Management Unit.

The three alternative measures intended to further minimize fire impacts in the Punapohaku area:

1) Complete 9 ha (23 ac) of fuel treatment along the interior of the northern portion of the north lobe of the firebreak road and treat 3 ha (8 ac) of area in a historically forested drainage to provide a continuous 60-m (197-ft) wide fuelbreak spanning the valley (Figure PD 10). The 20 m (65.6 ft) immediately inside the firebreak road will be kept shorter than 0.3 m (1 ft) and the total fuel load in the treatment area inside the firebreak road will be maintained at less than 3.5 tons/ac (to avoid spotting). The fuel treatment area inside the firebreak road will be kept cleared of shrubs taller than 0.6 m (2 ft). Fuel treatment may be completed by any means, including mowing, grazing, herbicide treatment, and prescribed burning. Within the portion of the fuelbreak extending from the firebreak road to the valley rim, areas larger than 30 m (98.4 ft) with grass cover greater than 20 percent will be removed with herbicide and aerial seeding with shrub and tree seeds to maintain grass cover less than 20 percent (see Figure PD 10). Approximately 60 percent of the shaded fuelbreak is currently dominated by dense shrub and forest vegetation and 40 percent of the area (3 ha; 7.4 ac) will require fuel treatment.

2) Reduce fuel loading on a landscape scale to provide an area for fire suppression resources to more efficiently suppress fires. The location and fuel treatment specifications will be finalized with the written approval of the Service. An example of reduced fuel loading treatment is intensive grazing of a 200-m (656-ft) wide fuelbreak in the vicinity of the north lobe of the firebreak road.

3) The Army will work with the Makua Implementation Team to develop protocols to ensure adequate protection for the *Bonamia menziesii*, *Chamaesyce celastroides* var. *kaenana*, *Euphorbia haeleeleana*, *Nototrichium humile* and *Schiedea hookeri* growing within and adjacent to Kaluakauila Management Unit. It may be necessary to develop additional measures such as stabilization actions including genetic storage for vulnerable individuals. Strategies may include analysis of genetic variability to determine the extent of seed storage necessary in order to represent the genetic diversity of the plant populations.

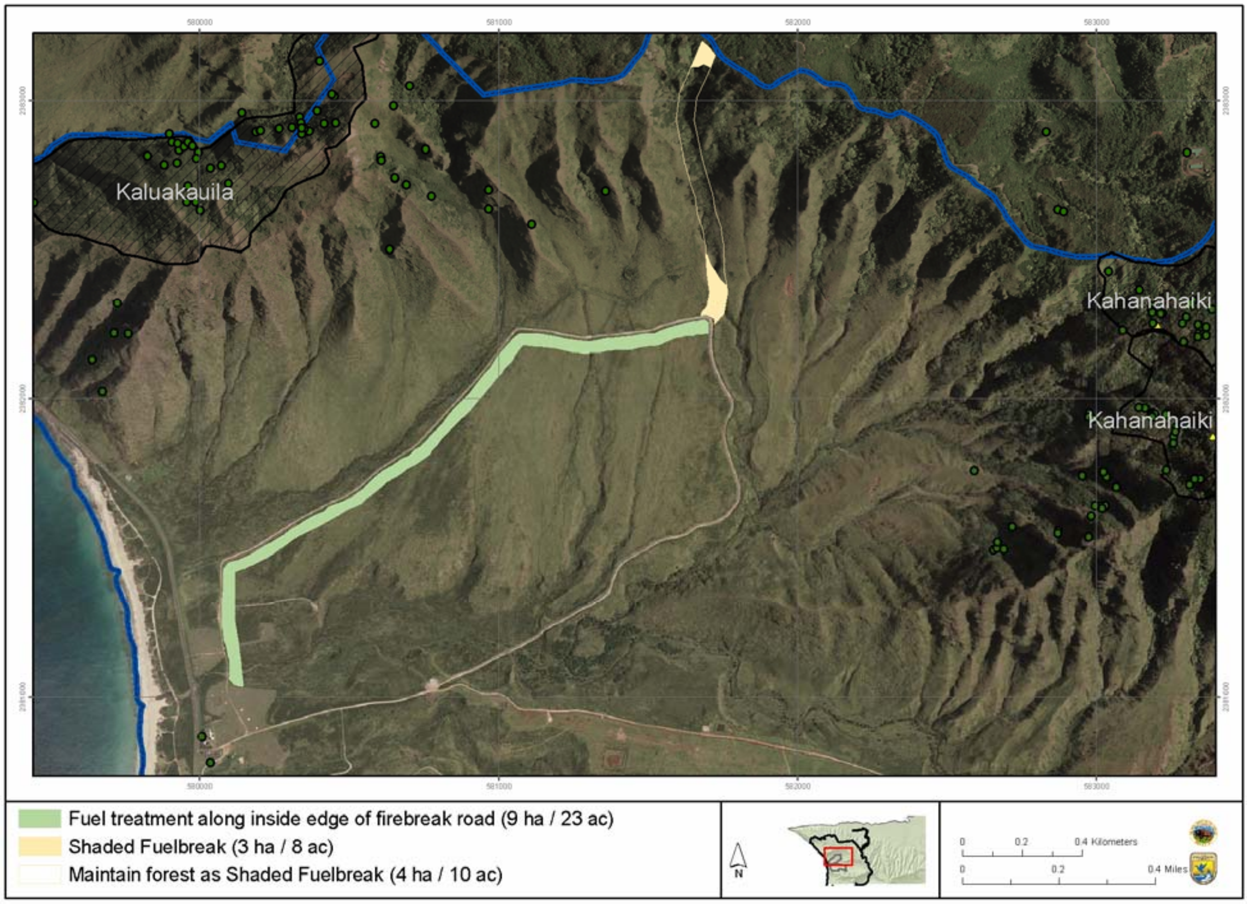


Figure PD 10. Fuel treatment alternative to minimize fire risk to endangered species in the Punapohaku area.

3.1.4.3 Ohikilolo Management Unit

The western tip of the Ohikilolo Management Unit will be protected from a fire burning from the north by a new 60-m (197-ft) wide fuelbreak (Figure PD 11). A grassy cliff area will be protected from fires with a combination of aerial herbicide and shrub seeding work. Work will begin within one year of the completion of this Biological Opinion so that within five years, the fuelbreak will be operational. Alternatives to this fuelbreak, which provide equal or greater protection to the 1,000 *Tetramolopium filiforme* plants in this vicinity, may be implemented instead, with the approval of the Service.

Figure PD 11. Ohikilolo strategic fuelbreak, approximate size and location.

3.2 Firefighting Personnel

A staffing protocol has been developed to ensure that adequate fire suppression resources are assigned to each live-fire training exercise at Makua. Staffing requirements vary by time of year and weapon system in use to ensure that adequate fire suppression force is assigned. During all training exercises when any weapon is being fired (including blanks) and during demolition exercises, Makua will be staffed, at minimum, by five NWCG-qualified, arduous level pack tested, red-carded wildland fire personnel with two Type 6 engines and one water tender. Assigned fire staff will include a minimum of one Type 4 NWCG-Qualified Incident Commander and two Engine Bosses (ENGB). Because the Army does not currently have staff to fill the ENGB positions, Engine Operators (NWCG Type 1 Firefighter with local engine experience) may be substituted for Engine Bosses until January 1, 2009. After January 1, 2009, use of personnel who have not completed NWCG prerequisites of training, experience, task book completion, and arduous level pack testing per PMS 310-1 National Interagency Incident Management System Wildland Fire Qualification System Guide January 2006 (as updated) will only be used to fill the five required NWCG-qualified firefighting staff positions at Makua in limited instances. Wildland firefighters who are unqualified for their assigned positions will demonstrate annual progress toward certification. No more than one of the five fire suppression personnel staffing Makua on any particular shift will be unqualified for their assigned position.

In the event of a large fire, additional ground forces, including red-carded Army Natural Resources Staff and firefighters from cooperating agencies are likely to be assigned to provide on-site protection to the Kaluakauila and Kahanahaiki management units and other areas. For pre-planning purposes, to maintain daily preparedness for a large fire outside the firebreak road, one fireline supervisor will be pre-assigned to coordinate suppression actions at the Kaluakauila Management Unit and another will be pre-assigned to direct suppression actions at the Kahanahaiki Management Unit. The assigned Incident Commander will document equipment, firefighter, pilot, and helicopter assignments on the Daily Staffing Worksheet.

The five Army wildland fire personnel assigned to staff Makua will rotate among the following positions: (1) one will be posted at all times during live-fire training on the top platform of the Range Control tower to watch for fire starts and document the times and locations of all rounds impacting outside the firebreak road (only grenades, mortars, artillery, AT-4, SMAW, 2.75-caliber rockets, Javelin, and TOW are likely to be visible enough to easily make determinations about impact locations); (2) one will be in the Range Control office confirming that WIMS is operating properly, confirming that actual weather is consistent with forecasted weather (and requesting an update to the forecast if there is a significant deviation), and confirming for the Incident Commander that Range Control staff are applying weapons restrictions properly in their radio communications with commanding officers conducting exercises down-range; (3) one will be in direct communication with all of the on-site helicopter pilots so that when a fire ignites, the helicopter response will not be delayed; and (4) the other two will work in the fire cache, and on equipment and local fuels projects.

When a wildland fire ignites, fire suppression will take precedence over training. If the fire is inside the firebreak road, the Incident Commander will determine when and for how long the range needs to be closed for fire suppression work to be conducted down-range. If the fire is outside the firebreak road, training will not commence until the fire is declared 100 percent contained by the Incident Commander. No fire outside the firebreak road will be declared 100 percent contained until the outer 60 m (197 ft) of the burned area is 100 percent mopped up and out. Thermal cameras mounted on Unmanned Aerial Vehicles may be used to determine fire containment. Because most of the area contains unexploded ordinance, containment will usually require substantial helicopter bucket work. At a minimum, an NWCG-qualified, pack tested, red-carded Incident Commander Type 4, plus one Type 2 Firefighter will remain on scene and on duty at Makua between 6 a.m. and 9 p.m. on all days when any fire is burning, inside or outside the firebreak road, until the fire is 100 percent contained. At a minimum, an NWCG-qualified, pack-tested, red-carded Incident Commander Type 5, plus one Type 2 Firefighter will remain on site at Makua overnight whenever there is a fire outside the firebreak road that has not been declared out. Once the fire is 100 percent contained, a minimum of one NWCG qualified, pack-tested, red-carded Incident Commander Type 5 or higher Army staff person will be on site and on duty at Makua between 6 a.m. and 9 p.m. on all days when any fire is burning inside or outside the firebreak road, until the fire is declared 100 percent out. No fire will be declared 100 percent out until a full 48 hours have passed since the last heat or smoke was found. Training will not occur on any day when there is not adequate fire resource staffing available to work during the entire duration of any potential fire suppression operation, including weekends and extended hours. Fires outside the firebreak road will only be declared out by the Army Wildland Fire Management Officer or Assistant Wildland Fire Management Officer. Fires inside the firebreak road will only be declared out by a red-carded, pack-tested U.S. Army Firefighter with minimum qualifications of NWCG Incident Commander Type 4. This will virtually eliminate "restart" as an ignition source at Makua. Helicopter resources will be assigned to exercises in accordance with a newly developed helicopter staffing protocol. All Incident Commanders assigned to live-fire training at Makua will know the locations of listed species and critical habitat and will have the authority to order any additional firefighting resources necessary to prevent the fire from burning those areas. The Incident Commander will have the authority to order additional helicopter support from cooperating agencies and private contractors.

The two Type 6 engines staffing Makua will be tested to ensure that they are running reliably and that they are pumping 100 psi water pressure on demand (within 5 minutes of beginning to pump with the engine) prior to initiation of live-fire training at Makua. A tested and operational engine or pump must be on site at Makua prior to initiating any training that requires fire suppression staffing. The water handling system on the two Type 6 engines will not be older than 15 years since its manufacture date. Engines and helicopters may apply foam and fire retardants in their fire suppression and containment operations, but these substances will not be applied within 100 m (328 ft) of streams, ponds, or the ocean.

3.3 Fire Suppression Helicopter/Aircraft Staffing

Helicopters or other aircraft will be used for both fire suppression and fire detection at Makua. Fire containment with air resources depends on the ability to perform at a pace in excess of the fire's rate of perimeter increase. Therefore, total combined continuous fireline productivity of on-site and total assigned helicopters will vary by season, forecasted fire weather and scheduled training activities.

Fire suppression helicopter staffing protocols have been designed for training and prescribed burns (Appendix D) based on the successful containment of guinea grass fires as determined by the CONTAIN module of BehavePlus fire behavior model (see Project Description, Section 9). The total combined continuous fireline productivity of on-site and standby fire suppression helicopters will vary by season, forecasted fire weather, and scheduled training activities. To provide for changes in the configuration of fire suppression aircraft staffing, as availability of various contract and military aircraft is affected by deployments and other factors, the total productivity of assigned aircraft is specified, rather than the type and number of particular helicopters.

Productivity rate estimates, designating the average rate of contiguous fire perimeter extinguished in an hour, have been established for various aircraft proposed for use at Makua (Table PD 4). The productivity rate in Table PD 4 are based on fire suppression capabilities demonstrated by Blackhawks, Hughes 500, and UH-1H Huey aircraft, extrapolated to other aircraft based on water capacity. Helicopter productivity is rated in chains/hour. A chain (ch) is a forestry measurement term utilized by the fire behavior software; one chain is 20.1 m (66 ft).

Table PD 4. Daytime Productivity Rates to be Used for Helicopters Assigned for Fire Suppression Staffing at Makua.

Day Time Aircraft Productivity Estimates for Fire Suppression at Makua Military Reservation

Aircraft Type	Pilot Type	Water Capacity	Not Fueled at Makua	Fueled at Makua	
			All Pilots and All Wind Conditions	20-foot wind speed 11 mph or higher OR No "F"-Type WIMS forecast for wind speed for all hours of scheduled use OR Pilots not yet approved by Army and Fish and Wildlife Service for Higher Productivity	20-foot wind speed "F"-type WIMS forecast: 10 mph or lower for current and next three hours AND Expert Pilots Approved by Army and Fish and Wildlife Service at These Productivity Rates
CL415	Contractor	1,800 gallons	**n.a.**	**57 chains/hr**	**171 chains/hr**
S61N or similar	Contractor	1,000 gallons	**13 chains/hr**	**45 chains/hr**	**135 chains/hr**
S61N or similar	Contractor	800 gallons	**10 chains/hr**	**36 chains/hr**	**108 chains/hr**
CH-47 Chinook	Military / Contractor	2000 gallons	**9 chains/hr**	**35 chains/hr**	**n.a.**
UH-60 Blackhawk	Military	660 gallons	**9 chains/hr**	**30 chains/hr**	**n.a.**
CH-46 Sea Knight	Military	400 gallons	**5 chains/hr**	**18 chains/hr**	**n.a.**
CH-53 Sea Stallion	Military	400 gallons	**5 chains/hr**	**18 chains/hr**	**n.a.**
Bell 210	Contractor	350 gallons	**5 chains/hr**	**17 chains/hr**	**51 chains/hr**
UH-1H Huey/ Bell 205 or 212	Contractor	340 gallons	**5 chains/hr**	**16 chains/hr**	**48 chains/hr**
Bell 407	Contractor	210 gallons	**3 chains/hr**	**10 chains/hr**	**30 chains/hr**
Bell 206 Long Ranger	Contractor	200 gallons	**3 chains/hr**	**10 chains/hr**	**20 chains/hr**
Bell Jet Ranger	Contractor	120 gallons	**2 chains/hr**	**6 chains/hr**	**19 chains/hr**
Hughes 500	Contractor	110 gallons	**2 chains/hr**	**6 chains/hr**	**18 chains/hr**

Historically, difficulties have resulted when helicopters have not had access to fuel on-site at Makua. For a particular helicopter's productivity to be assessed as having on-site fueling capability, a fuel tank or fuel truck will be placed at Makua with enough of the appropriate fuel on board to provide 10 hours of flight time for that helicopter. The fuel truck or tank will be compatible with the helicopter, and all Army and contract requirements will be finalized prior to initiation of training or prescribed burning so refueling will be immediately available as needed during the helicopters assigned shift and it will not take longer than 15 minutes to accomplish. If multiple helicopters will be fueling from the same truck or tank, the truck or tank will have, at the beginning of the fire, enough fuel on-site for 10 hours of flight time of all of the helicopters that the truck is supporting. In fire situations when visibility at the Range Control helipads is poor, an alternate on-site refueling area may be established at another location within 5 km (3 mi) of the Makua Range Control helipads.

To ensure that productivity rates in the table would be met by all pilots, productivity rates for the least productive pilots are used as a basis for rating particular classes of aircraft. Therefore, the rates in Table PD 4 are expected to be conservative. Army will document by video recording, still photography, or other method that enables independent verification, the fire suppression helicopter productivity, in grass fuels, during the first hour of all wildland fires occurring outside the firebreak road at Makua. Office of Aircraft Services – Certified pilots, and other pilots with fire suppression experience may be given the higher productivity rates listed in Table PD 4 with the approval of the Army and the Service. The Army may develop and submit revised fire suppression aircraft productivity ratings for individual pilots or classes of aircraft for specific fuel moisture and wind conditions. Individual pilots or classes of aircraft may be given ratings higher than those in Table PD 4 if sufficient documentation is available to substantiate the assignment of the revised rates. The revised rates and supporting documentation will be submitted to the Service for review prior to the replacement of the rates listed in Table PD 4 for use satisfying fire suppression staffing requirements at Makua. Given the approval of the Service's Field Supervisor, updated rates may be appended to the Biological Opinion for use satisfying the fire suppression helicopter staffing requirements specified in this Project Description.

Fire suppression staffing for live-fire training will meet or exceed the minimum requirements listed in Table PD 5. Helicopter staffing will be based on two fire weather parameters documented in WIMS for Makua Range weather station number 490301: (1) live herbaceous fuel moisture for the previous day, and (2) National Weather Service "F" type observations of wind speed for all hours of training and for the one to two hourly observations immediately following each period of training. General fire weather forecasts and spot fire weather forecasts issued by National Weather Service forecasters will not be used to make determinations about helicopter fire suppression staffing. Hourly "F" type WIMS observations input by the National Weather Service forecaster into WIMS must be used. If no "F" type WIMS observation is available, helicopters will be staffed for wind speeds of 16 mph or higher

Response times for standby helicopters are maximum estimates. Standby helicopters will often be called in to support suppression actions on larger fires inside the firebreak road. The Army Incident Commander assigned to the fire will release standby helicopters as they are no longer needed. Often, the spread of a fire outside the firebreak road will be successfully halted by the on-site helicopters and standby helicopters will be cancelled prior to their arrival on the fire.

When blanks are fired from designated mowed areas which are separated from patches of tall grass by a bare mineral soil firebreak, wide enough to stop a fire burning in the mowed grass fuels, no helicopter staffing will be required. When blanks are fired from areas which are not mowed or which are not separated from taller grass fuels by a firebreak, fire suppression helicopters will be staffed pursuant to fire suppression helicopter staffing guidelines specified for 5.56 SRTA (Table PD 5).

Table PD 5 (On Following Page). Helicopter Staffing: Minimum Helicopter Fire Suppression Capability Assigned to Daytime Live-fire Training at Makua by Time of Year and Potential Fire Ignition Location.

Wind Directions N, NNE, NE, ENE, E, and ESE Only: Fire Suppression Helicopter (Aircraft) Staffing Requirements(*1): Minimum Fire Suppression Capability (*2) of Fire Suppression Helicopters Assigned for Water Drops During Exercises at Makua (*3)(*4)(*5)(*6)								
Maximum 10-minute average 20-foot windspeed and direction for WIMS station # 490301, Makua Range, for all WIMS "F" Type Observations issued by Nat'l Weather Serv. for all hours of training and the one or two hourly observations immediately following completion of training (*7).	**Live Herbaceous Fuel Moisture - WIMS Calculated on Previous Day**							
	200 % or higher (*5)	**150 % - 199 % (*5)**	**120 % - 149 %**	**100 % - 119 %**	**80 % - 99 %**	**70 % - 79 %**	**60 % - 69 %**	**50 % - 59 % (Blanks/Ball Ammo Only (*6))**
5 mph or less, Direction N through ESE Only	17 chains/hr (9 on-site / 8 standby)	21 chains/hr 11 on-site / 10 standby)	25 chains/hr (13 on-site / 12 standby)	41 chains/hr (21 on-site / 20 standby)	71 chains/hr (30 on-site / 41 standby)	78 chains/hr (30 on-site / 48 standby)	87 chains/hr (30 on-site / 57 standby)	97 chains/hr (30 on-site/ 67 standby)
6 - 10 mph, Direction N through ESE Only	26 chains/hr (13 on-site / 13 standby)	31 chains/hr (16 on-site / 15 standby)	37 chains/hr (19 on-site / 18 standby)	63 chains/hr (30 on-site / 33 standby)	113 chains/hr (30 on-site / 83 standby)	124 chains/hr (30 on-site / 94 standby)	138 chains/hr (30 on-site / 108 standby)	154 chains/hr (60 on-site/ 94 standby)
11 - 15 mph, Direction N through ESE Only	35 chains/hr (18 on-site / 17 standby)	44 chains/hr (22 on-site / 22 standby)	52 chains/hr (26 on-site / 26 standby)	90 chains/hr (30 on-site / 60 standby)	164 chains/hr (30 on-site / 134 standby)	180 chains/hr (30 on-site / 150 standby)	200 chains/hr (60 on-site / 140 standby)	224 chains/hr (60 on-site / 164 standby)
16 mph or higher (or if no NWS "F" Type Observation WIMS Forecast Issued for All Hours of Training)	42 chains/hr (10 on-site / 32 standby)	52 chains/hr (13 on-site / 39 standby)	62 chains/hr (30 on-site / 32 standby)	107 chains/hr (30 on-site / 77 standby)	197 chains/hr (60 on-site / 137 standby)	217 chains/hr (60 on-site / 157 standby)	241 chains/hr (60 on-site / 181 standby)	270 chains/hr (90 on-site / 180 standby)

For Wind Directions other than E, NE, and E forecasted in WIMS "F"-Type forecast								
Maximum 10-minute average 20-foot windspeed for WIMS station # 490301, Makua Range, for all WIMS "F" Type Observations issued by Nat'l Weather Serv. for all hours of training and the one or two hourly observations immediately following completion of training (*7).	**Live Herbaceous Fuel Moisture - WIMS Calculated on Previous Day**							
	200 % or higher (*5)	**150 % - 199 % (*5)**	**120 % - 149 %**	**100 % - 119 %**	**80 % - 99 %**	**70 % - 79 %**	**60 % - 69 %**	**50 % - 59 % (Blanks/Ball Ammo Only (*6))**
5 mph or less: Wind Direction Not Specified	22 chains/hr (11 on-site / 11 standby)	28 chains/hr (14 on-site / 14 standby)	34 chains/hr (17 on-site / 17 standby)	56 chains/hr (28 on-site / 28 standby)	98 chains/hr (30 on-site / 68 standby)	108 chains/hr (30 on-site / 78 standby)	120 chains/hr (30 on-site / 90 standby)	135 chains/hr (60 on-site/ 75 standby)
6 - 10 mph Wind Direction Not Specified	33 chains/hr (17 on-site / 16 standby)	42 chains/hr (21 on-site / 21 standby)	49 chains/hr (25 on-site / 24 standby)	86 chains/hr (30 on-site / 56 standby)	150 chains/hr (30 on-site / 120 standby)	165 chains/hr (30 on-site / 35 standby)	183 chains/hr (30 on-site / 153 standby)	206 chains/hr (90 on-site/ 116 standby)
11 - 15 mph Wind Direction Not Specified	41 chains/hr (21 on-site / 20 standby)	50 chains/hr (25 on-site / 25 standby)	60 chains/hr (30 on-site / 30 standby)	104 chains/hr (30 on-site / 74 standby)	182 chains/hr (30 on-site / 152 standby)	201 chains/hr (60 on-site / 141 standby)	223 chains/hr (60 on-site / 163 standby)	250 chains/hr (90 on-site / 160 standby)
16 mph or higher (or if no NWS "F" Type Observation WIMS Forecast Issued for All Hours of Training)	42 chains/hr (21 on-site / 21 standby)	52 chains/hr (26 on-site / 26 standby)	62 chains/hr (30 on-site / 32 standby)	107 chains/hr (30 on-site / 77 standby)	197 chains/hr (60 on-site / 137 standby)	217 chains/hr (60 on-site / 157 standby)	241 chains/hr (60 on-site / 181 standby)	270 chains/hr (90 on-site / 180 standby)

(*1) Table indicates total fire suppression helicopter staffing assigned to Makua, including on-site and standby resources. On-site helicopters will have buckets attached and tested so that their first full load of water is dropped on the fire's perimeter within 15 minutes of the fire's ignition. The other assigned helicopters will be positioned so that their first full load of water is dropped on the fire perimeter within one hour of any fire's ignition outside the firebreak road. The assigned incident commander will maintain a list of additional unassigned helicopters which are likely to be available to support fire suppression efforts at Makua, with two hour response times, in the event of a need for contingency resources.

(*2) Fire suppression capability, or fireline construction rate of all fire suppression helicopters is rated in chains/hour. Chains/hour indicates the continuous helicopter fireline construction rate (third hour of production) in dense, long-unburned guinea grass at Makua and is a function of turnaround time, length of fire perimeter each water drop extinguishes, and percent of time that is unproductive due to refueling. Refer to Helicopter Productivity Table or individual pilot qualifications card for helicopter productivity rates.

(*3) No helicopters required - rain and blanks in designated areas: No fire suppression helicopter staffing is required when the most recent hourly WIMS-calculated 1-hr and 10-hr fuel moisture values for all three of the Makua WIMS weather stations (490301, 490302, and 490303) are 35 percent or higher as a result of documented precipitation registered at all three weather stations. When only blanks are being fired from firing points in mowed objectives which are separated from tall grass areas by a bare mineral soil firebreak, no helicopter staffing is required.

(*4) Reduced Total Helicopter Staffing for 5.56 SRTA Ball Ammo: When the grass within 60 meters along the inside edge of the south lobe of the firebreak road is mowed to one foot height or less, and the SRTA firing points are separated from unmowed grass areas by a bare mineral soil break, only 30 chains/hr of total fire suppression helicopter support is required to be on-site. No additional standby helicopters are required. A list of available contingency helicopters will be kept by the incident commander, but because these aircraft will not be assigned to Makua until after a fire ignition, response times for contingency aircraft are likely to be several hours.

(*5) No on-site helicopter: When Live Herbaceous Fuel Moisture at WIMS Station 490301 is 150 percent or higher Ball Ammunition, Demolitions and Hand Grenades and Smoke Grenades in designated pits or designated bare mineral soil areas inside the south lobe of the firebreak road may be used with no on-site helicopter. Full fire suppression helicopter staffing would be assigned to Makua with a one hour response time. The grass within 60 meters along the inside edge of the south lobe of the firebreak road is mowed to one foot height or less (or live herbaceous fuel moisture measured within the past week is 200 percent or greater) in order for the on-site helicopter requirement to be waived for these weapons.

(*6) The following reduced on-site fire suppression helicopter staffing applies only when the grass within 60 meters along the inside edge of the south lobe of the firebreak road is mowed to one foot height or less: When ball ammunition, hand grenades or demolitions are being used only in designated grass-free pits in Green fire danger rating conditions, on-site fire suppression staffing may be reduced to one half of the staffing level shown in the table. Total helicopter staffing would not be affected. The helicopter(s) which would have been on-site would respond, along with the other standby helicopters assigned to Makua so their first full load of water would be dropped on the fire perimeter within one hour of any fire's ignition outside the firebreak road.

(*7) If no "F" type observation is available in WIMS for each hour of training and for the hour following training, helicopters will be staffed for windspeeds of 16 mph or higher. If training is occurring in the yellow, helicopter staffing will be determined based on the highest wind speed and worst-case wind direction forecasted in an "F" type forecast during all hours of training and for the two hourly "F" type hourly observations immediately following the end of all periods of training. For training which is scheduled to occur only during green fire danger periods, helicopter staffing will be determined based on the highest wind speed and worst wind direction forecasted in an "F" type forecast during all hours throughout the period of scheduled training and for the hourly "F" type observation immediately following all periods of training.

Green and Yellow Fire Danger conditions suitable for training rarely occur in grey shaded boxes.

Regardless of whether fueling will be done on-site or back at Wheeler, the on-site assigned fire suppression helicopters standing by during exercises at Makua will maintain enough fuel on board to provide one hour of continuous fire bucket operation in addition to any fuel needed to fly to the refueling site after the first hour of work is done. On-site fire suppression helicopters may fly missions in Makua valley during their assigned standby time as long as their buckets remain attached after testing and they maintain the minimum fuel necessary to always fulfill their one-hour minimum fire suppression flight time requirement. If an on-site fire suppression helicopter's fuel falls below the minimum required one-hour fuel level, live-fire training will be suspended until the helicopter is adequately fueled.

Helicopter staffing for prescribed burns is specified in Prescribed Burn Plan MMR 06-03 (see Appendix D). Until all Kaluakauila Management Unit fire minimization measures (see Project Description Section 3.1.4.2) are completed, all assigned fire suppression helicopters, including standby helicopters, will be located on-site at Makua when prescribed burning is conducted inside the north lobe of the firebreak road. Fire minimization measures are scheduled to be completed prior to implementation of Column C weapons restrictions, or within the first five years after the completion of this Biological Opinion.

Currently, the Army does not utilize helicopters for fire suppression at Makua after legal twilight, which occurs approximately 30 minutes after sunset. To minimize the risk of a fire ignition so late in the day that the fire would be left to burn without this fire suppression resource overnight, weapon use will be curtailed prior to sunset. As long as the fire danger rating recorded by WIMS for the Makua Range weather station is Green, weapon use may continue until one hour prior to legal twilight. When the fire danger rating is Yellow, weapon use will stop two hours prior to legal twilight. Night productivity rates for helicopters conducting fire suppression operations have not been determined, but are likely to be low. Night productivity rates for helicopters will be determined when the Army allows nighttime helicopter fire suppression. The Army will submit proposed night productivity rates to the Service for approval, and the new rates will be appended to this Biological Opinion prior to the implementation of night live-fire training at Makua. If limitations are placed on the number of helicopters permitted for use at one time on a fire suppression assignment in Makua valley, then the helicopter staffing requirements will be met with the use of higher productivity aircraft. More productive aircraft are likely to be necessary for fire suppression work when live herbaceous fuel moistures are lower.

Of the 40 new fuel models described in Scott and Burgan (2005), guinea grass has a greater total fuel load than all except for the four slash fuel models and four other heavy fuel models (SH7 Chaparral, SH9 Florida Scrub, TU5 and TL9 heavy forest understory or litter). Guinea grass fuel load estimates range from 8.8 to 11 tons per acre with fuel bed depth estimates between 1.88 and 5 feet (Beavers 2001; Wright et al 2002; Scott and Burgan 2005). Anticipated fire behavior, lack of barriers to fire spread, the high value of resources at risk, and the otherwise scarce availability of aircraft necessitate confirmation of availability of fire suppression helicopters to suppress a fire or spot fire occurring at any location in Makua on days when live-fire training is scheduled. Fire suppression helicopter staffing requirements are based on the performance of helicopters in relation to predicted growth of fires burning in guinea grass. Examples of predicted fire acreages are presented in Section 9. As the guinea grass fuel model is refined and researchers gain a more thorough understanding of rate of spread of headfires burning in mature stands of guinea grass under various live herbaceous fuel moisture, dead fuel moisture, and wind conditions, adjustments may be made to the Makua fire suppression helicopter staffing guidelines so that the fire sizes predicted by the CONTAIN module of BehavePlus remain equal to or are smaller than the acreages predicted by this fire spread model, utilizing the current guinea grass fuel model parameters and the current helicopter staffing guidelines. Changes in the guinea grass fuel model may result in either increases or decreases in the fire suppression helicopter staffing requirements. Updated helicopter staffing requirements, agreed to in writing by the Service Field Supervisor, will be appended to the Biological Opinion and will replace the requirements currently specified in Table PD 5. Updated helicopter staffing guidelines will not be instituted at Makua without this prior written approval of the Service Field Supervisor.

3.4 Fire Reconnaissance

In accordance with the requirements specified in Table PD 5, at least one fire suppression helicopter will be on site at Makua during, and for one hour following live-fire training activities except when 2.75-caliber rockets, Javelin, and TOW weapons are fired, in which case, the on-site helicopter(s) will remain on site for two hours following the use of these types of ammunition. When 2.75-caliber rockets, a Javelin, or a TOW has been fired at Makua, all wildland fire ground forces and at least one on-site fire suppression helicopter will remain on site for two hours after the last round from one of these weapons is fired to better ensure that all fires outside the firebreak road are able to grow large enough to be identified and extinguished. The helicopter(s) will take the assigned Incident Commander (and, if there are multiple aircraft available, the Engine Bosses) for a one-hour reconnaissance flight over the surface danger zones of the weapons fired so that the area, particularly the forested area, can be thoroughly checked for fire ignitions.

3.5 Dip Site and Water Supply

The upper dip site must be supplied with enough water to continuously keep half of the total assigned helicopters operating at full productivity. Within the next five years, the existing 4 cm (1.5 in) pipe distributing water from the city's water meter will be upgraded to provide increased flow capacity, the water storage tank at the Makua Range office will be upgraded to hold 227,000 liters (60,000 gallons), and an overhead stand pipe fill station will be added to ease engine refill.

3.6 Wildland Fire Reporting

Several wildland fire reporting requirements will be implemented. First, at the commencement of firefighter and helicopter staffing periods, the assigned Army Incident Commander will document the names, qualifications, and equipment types of each of the firefighters and pilots staffing Makua. On any day when wind speeds greater than 16 mph are forecasted, the availability of contingency helicopter(s) with two-hour availability will be documented. This form will be faxed or emailed to the Service's Makua Biological Opinion Implementation Biologist within one hour of the beginning of each daily or nightly period that Makua is staffed for fire suppression. An example of the Makua Daily Staffing worksheet is shown in PD 12 (see Pages 49 and 50).

Makua Fire Suppression Daily Staffing Worksheet - Day Shift. Date: ____/_____/2007
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Helicopter Productivity Worksheet:

A. What is the Live Herbaceous Fuel Moisture %, Calculated for Makua Range Weather Station (WIMS Station # 490301) for the Previous Day:	**____________________%**
Has the National Weather Service Fire Weather Forecaster Issued an F-Type WIMS Observation for all hours of training?	**Yes / No**
What is the Maximum 10-minute Average 20-Foot Wind Speed Forecasted in WIMS "F" Type National Weather Service for all hours of training and for the the hour immediately following completion of training (If F-Type Observations incomplete, use 16 mph)?	**__________Miles/Hour**
What is the Total Fire Suppression Helicopter Productivity Required (Chains/hour):	**______Total chains/hour**
What is the regular on-site helicopter fire suppression force required (Chains/hour)?	**_____On-site chains/hour**
Is the 60 meters along the inside edge of the south lobe of the firebreak road mowed to 1 foot height?	**Yes / No**
Are blanks, ball ammunition, and demolitions, hand grenades, and smoke grenades in designated pits or designated bare mineral soil areas the only weapons being used?	**Yes / No**
Reduced on-site helicopter staffing: If Blanks, ball ammunition, and/or demolitions and hand grenades in designated grass-free pits are the ONLY things being used, and the 60 meter area inside the south lobe of the firebreak road is mowed to a height of 1 foot or less, then 1/2 of the regular on-site helicopter fire suppression force may be assigned.	**Blanks, Ball Ammo, Demolitions, Hand Grenades, Smoke Grenades 1/2 on-site:_________ch/hr**
No on-site helicopter staffing: Is Live Herbaceous Fuel Moisture 150 percent or higher? Is the 60 meters along the inside edge of the south lobe of the firebreak road mowed to 1 foot height? If answer is yes to all three questions, no helicopter is required to be on-site. All helicopter staffing will respond within one hour of fire ignition outside firebreak road.	**Live Herbaceous 150 Percent and Higher: Blanks, Ball Ammo, Demolitions, Hand Grenades, Smoke Grenades on-site _________ch/hr**

Use these results to assign individual helicopters for training at Makua on table on page 2

Wind Directions N, NNE, NE, ENE, E, and ESE Only: Fire Suppression Helicopter (Aircraft) Staffing Requirements(*1): Minimum Fire Suppression Capability (*2) of Fire Suppression Helicopters Assigned for Water Drops During Exercises at Makua (*3)(*4)(*5)(*6)

Maximum 10-minute average 20-foot windspeed and direction for WIMS station # 490301, Makua Range, for all WIMS "F" Type Observations issued by Nat'l Weather Serv. for all hours of training and the one or two hourly observations immediately following completion of training (*7).	**Live Herbaceous Fuel Moisture - WIMS Calculated on Previous Day**							
	200 % or higher (*5)	**150 % - 199 % (*5)**	**120 % - 149 %**	**100 % - 119 %**	**80 % - 99 %**	**70 % - 79 %**	**60 % - 69 %**	**50 % - 59 % (Blanks/Ball Ammo Only (*6))**
5 mph or less, Direction N through ESE Only	17 chains/hr (9 on-site / 8 standby)	21 chains/hr 11 on-site / 10 standby)	25 chains/hr (13 on-site / 12 standby)	41 chains/hr (21 on-site / 20 standby)	71 chains/hr (30 on-site / 41 standby)	78 chains/hr (30 on-site / 48 standby)	87 chains/hr (30 on-site / 57 standby)	97 chains/hr (30 on-site/ 67 standby)
6 - 10 mph, Direction N through ESE Only	26 chains/hr (13 on-site / 13 standby)	31 chains/hr (16 on-site / 15 standby)	37 chains/hr (19 on-site / 18 standby)	63 chains/hr (30 on-site / 33 standby)	113 chains/hr (30 on-site / 83 standby)	124 chains/hr (30 on-site / 94 standby)	138 chains/hr (30 on-site / 108 standby)	154 chains/hr (60 on-site/ 94 standby)
11 - 15 mph, Direction N through ESE Only	35 chains/hr (18 on-site / 17 standby)	44 chains/hr (22 on-site / 22 standby)	52 chains/hr (26 on-site / 26 standby)	90 chains/hr (30 on-site / 60 standby)	164 chains/hr (30 on-site / 134 standby)	180 chains/hr (30 on-site / 150 standby)	200 chains/hr (60 on-site / 140 standby)	224 chains/hr (60 on-site / 164 standby)
16 mph or higher (or if no NWS "F" Type Observation WIMS Forecast Issued for All Hours of Training)	42 chains/hr (10 on-site / 32 standby)	52 chains/hr (13 on-site / 39 standby)	62 chains/hr (30 on-site / 32 standby)	107 chains/hr (30 on-site / 77 standby)	197 chains/hr (60 on-site / 137 standby)	217 chains/hr (60 on-site / 157 standby)	241 chains/hr (60 on-site / 181 standby)	270 chains/hr (90 on-site / 180 standby)

For Wind Directions other than E, NE, and E forecasted in WIMS "F"-Type forecast

Maximum 10-minute average 20-foot windspeed for WIMS station # 490301, Makua Range, for all WIMS "F" Type Observations issued by Nat'l Weather Serv. for all hours of training and the one or two hourly observations immediately following completion of training (*7).	**Live Herbaceous Fuel Moisture - WIMS Calculated on Previous Day**							
	200 % or higher (*5)	**150 % - 199 % (*5)**	**120 % - 149 %**	**100 % - 119 %**	**80 % - 99 %**	**70 % - 79 %**	**60 % - 69 %**	**50 % - 59 % (Blanks/Ball Ammo Only (*6))**
5 mph or less: Wind Direction Not Specified	22 chains/hr (11 on-site / 11 standby)	28 chains/hr (14 on-site / 14 standby)	34 chains/hr (17 on-site / 17 standby)	56 chains/hr (28 on-site / 28 standby)	98 chains/hr (30 on-site / 68 standby)	108 chains/hr (30 on-site / 78 standby)	120 chains/hr (30 on-site / 90 standby)	135 chains/hr (60 on-site/ 75 standby)
6 - 10 mph Wind Direction Not Specified	33 chains/hr (17 on-site / 16 standby)	42 chains/hr (21 on-site / 21 standby)	49 chains/hr (25 on-site / 24 standby)	86 chains/hr (30 on-site / 56 standby)	150 chains/hr (30 on-site / 120 standby)	165 chains/hr (30 on-site / 35 standby)	183 chains/hr (30 on-site / 153 standby)	206 chains/hr (90 on-site/ 116 standby)
11 - 15 mph Wind Direction Not Specified	41 chains/hr (21 on-site / 20 standby)	50 chains/hr (25 on-site / 25 standby)	60 chains/hr (30 on-site / 30 standby)	104 chains/hr (30 on-site / 74 standby)	182 chains/hr (30 on-site / 152 standby)	201 chains/hr (60 on-site / 141 standby)	223 chains/hr (60 on-site / 163 standby)	250 chains/hr (90 on-site / 160 standby)
16 mph or higher (or if no NWS "F" Type Observation WIMS Forecast Issued for All Hours of Training)	42 chains/hr (21 on-site / 21 standby)	52 chains/hr (26 on-site / 26 standby)	62 chains/hr (30 on-site / 32 standby)	107 chains/hr (30 on-site / 77 standby)	197 chains/hr (60 on-site / 137 standby)	217 chains/hr (60 on-site / 157 standby)	241 chains/hr (60 on-site / 181 standby)	270 chains/hr (90 on-site / 180 standby)

Makua Fire Suppression Daily Staffing Worksheet - Day Shift. Date: ____/_____/2007

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Ground Resources Assigned:

Staff Position:	NWCG-Qualified Person Assigned
NWCG-qualified IC Type 4 (or other person approved by Service):	
NWCG Engine Boss (#1) (ENOP until 1/1/2009):	
Type 6 (or larger) Engine Equip #:	Assigned to Kaluakauila or Kahanahaiki (circle one)
Firefighter Type 2:	
NWCG Engine Boss (#2) (ENOP until 1/1/2009 and after 1/1/09 with Service approval):	
Type 6 (or larger) Engine Equip #:	Assigned to Kaluakauila or Kahanahaiki (circle one)
Firefighter Type 2:	
Water Tender Number:	

Required On-Site combined Helicopter Productivity (from page 1):	On-site ______ ch/hr
Required Total helicopter productivity (On-site + Standby) from tables on Pageg 1:	**Total _______chains/hr**

Helicopters Assigned to Satisfy Staffing Requirements: See productivity table below or highly skilled pilot's "red card" for rating.

Tail #	Pilot Name, Phone#	Fuel on site?	Helo. Productivity
On-site:		Yes / No	_______chains/hr
On-site:		Yes / No	_______chains/hr
On-site:		Yes / No	_______chains/hr
On-site:		Yes / No	_______chains/hr
Subtotal: On-site chains/hour			On-site total______ ch/hr
Standby:		Yes / No	_______chains/hr
Standby:		Yes / No	_______chains/hr
Standby:		Yes / No	_______chains/hr
Standby:		Yes / No	_______chains/hr
Subtotal: standby helicopter productivity (chains/hour):			Standby subtotal___ ch/hr
Total helicopter productivity assigned (On-site + Standby):			**Total _______chains/hr**

Day Time Aircraft Productivity Estimates for Fire Suppression at Makua Military Reservation

Aircraft Type	Pilot Type	Water Capacity	Not Fueled at Makua	Fueled at Makua	
			All Pilots and All Wind Conditions	**20-foot wind speed 11 mph or higher OR No "F"-Type WIMS forecast for wind speed for all hours of scheduled use OR Pilots not yet approved by Army and Fish and Wildlife Service for Higher Productivity**	**20-foot wind speed "F"-type WIMS forecast: 10 mph or lower for current and next three hours AND Expert Pilots Approved by Army and Fish and Wildlife Service at These Productivity Rates**
CL415	Contractor	1,800 gallons	**n.a.**	**57 chains/hr**	**171 chains/hr**
S61N or similar	Contractor	1,000 gallons	**13 chains/hr**	**45 chains/hr**	**135 chains/hr**
S61N or similar	Contractor	800 gallons	**10 chains/hr**	**36 chains/hr**	**108 chains/hr**
CH-47 Chinook	Military / Contractor	2000 gallons	**9 chains/hr**	**35 chains/hr**	**n.a.**
UH-60 Blackhawk	Military	660 gallons	**9 chains/hr**	**30 chains/hr**	**n.a.**
CH-46 Sea Knight	Military	400 gallons	**5 chains/hr**	**18 chains/hr**	**n.a.**
CH-53 Sea Stallion	Military	400 gallons	**5 chains/hr**	**18 chains/hr**	**n.a.**
Bell 210	Contractor	350 gallons	**5 chains/hr**	**17 chains/hr**	**51 chains/hr**
UH-1H Huey/ Bell 205 or 212	Contractor	340 gallons	**5 chains/hr**	**16 chains/hr**	**48 chains/hr**
Bell 407	Contractor	210 gallons	**3 chains/hr**	**10 chains/hr**	**30 chains/hr**
Bell 206 Long Ranger	Contractor	200 gallons	**3 chains/hr**	**10 chains/hr**	**20 chains/hr**
Bell Jet Ranger	Contractor	120 gallons	**2 chains/hr**	**6 chains/hr**	**19 chains/hr**
Hughes 500	Contractor	110 gallons	**2 chains/hr**	**6 chains/hr**	**18 chains/hr**

Figure PD 12. Two page Makua Daily Fire Suppression Staffing Worksheet to be completed and faxed to the Service each day that Makua is staffed by fire suppression personnel.

The Army will inform the Service's Makua Biological Opinion Implementation Biologist, via telephone, within one hour of any fire burning outside the firebreak road at Makua. Subject to updates, contact information for the Service's Makua Biological Opinion Implementation Biologist is: Dawn Greenlee, phone (808) 792-9469, cell phone (808) 927-4602, fax (808) 792-9580. In order to substantiate the productivity rates and helicopter staffing guidelines proposed in this Project Description, the Army will document by video recording, still photography, or other method that enables independent verification, the fire rate of spread and fire suppression helicopter productivity during the first hour of all wildland fires burning grass areas outside the firebreak road at Makua. Complete, unedited copies of all video or other data will be provided to the Service. Service staff may view any military activities or fires at Makua from the vicinity of the tower at the Range Control office at any time. Service staff may obtain additional information about any fires or activities at Makua from Army Department of Public Works staff or personnel designated by Department of Public Works to provide information to Service staff. The Army will provide the Service with copies of fire reports for all, regardless of location or cause, wildland fires occurring at Makua on a quarterly basis. A list of the date, time, and location of all munitions impacting outside the south lobe of the firebreak road will also be provided to the Service each quarter.

The Army will invite the Service to a meeting or After Action Review regarding all fires that occur outside the firebreak road at Makua or that burn on-site or off-site Makua Implementation Plan management units within 10 days of the incident. The Army will provide the Service with complete copies of video or other data taken during the fire and evaluation of the fire suppression response and final fire acreage of all fires in relation to the fire size predicted by the CONTAIN module of the BehavePlus fire behavior model.

3.7 Prescribed Burning

The Army may conduct prescribed burns within the north and south lobes of the firebreak roads to reduce fuels, prepare sites for unexploded ordinance clearance, or for other purposes, in accordance with the Prescribed Burn Plan MMR 06-03 in Appendix D. The prescription that will be used to conduct such burns at Makua is included in this Project Description (Section 9). No prescribed burn will be conducted without an on-site observer from the Service, without the prior approval of the Service. In summary, the burns will be conducted only when live herbaceous fuel moisture is 100 percent or higher, under cool burning conditions with minimum one-hour fuel moistures of eight percent under most conditions, with highly skilled staff, and with adequate on-site and standby fire suppression forces assigned to contain spot fires. Helicopter staffing for prescribed burns is specified in Prescribed Burn Plan MMR 06-03 (see Appendix D). Until all Kaluakauila Management Unit fire minimization measures (see Project Description Section 3.1.4.2) are completed, all assigned fire suppression helicopters, including standby helicopters, will be located on-site at Makua when prescribed burning is conducted inside the north lobe of the firebreak road. Fire minimization measures are scheduled to be completed prior to implementation of Column C weapons restrictions, or within the first five years after the completion of this Biological Opinion. Live-fire training and prescribed burning will be suspended, after five years of the completion of this Biological Opinion, unless the fuelbreaks and firebreaks specified in this Project Description are completed and maintained. The fire suppression helicopter staffing requirements specified in Prescribed Burn Plan MMR 06-03 will be updated, with the approval of the Service, as the guinea grass fuel model is updated to incorporate new fire rate of spread data. Alterations, which do not increase the fire risk to endangered species and critical habitats, may be made to Prescribed Burn Plan MMR 06-03, with the approval of the Service. Prescribed Burn Plan MMR 06-03 (see Appendix D) is the only prescribed burn prescription covered under this Biological Opinion. The Army will conduct separate consultations with the Service for any prescribed burns at Makua which are not covered by Prescribed Burn Plan MMR 06-03.

3.8 WIMS Weather Observations

Range use restrictions are driven by indices calculated by the National Fire Danger Rating System (NFDRS) calculator in WIMS for the Makua Range weather station number 490301. Three NFRDS remote automated weather stations, maintained in accordance with NWCG National Fire Danger Rating System Weather Station Standards, PMS 426-3, May 2005 (http://www.fs.fed.us/raws/standards/NFDRS_final_revmay05.pdf), using NFDRS fuel model N, Climate Class 2, 1978 model, will be maintained at their current locations at Makua. Once each year, when cured grass starts to turn green again (approximately November 1), the stations will be “greened up” in WIMS. Activities with higher risk of igniting wildland fires are restricted to periods of low and medium fire danger when fires will be less likely to ignite and easier to suppress. Weapons restrictions in Table PD 2 are color coded based on the maximum fire danger, based on the burning index calculated by WIMS, under which the weapon will be used.

Weather observations are collected automatically each hour by the weather station and transmitted via satellite to servers that automatically disseminate the information to WIMS, which is accessed via internet. Weather observations are automatically taken at two minutes before the hour and are available for viewing in WIMS by 7 to 10 minutes after the hour. Once the data becomes available in WIMS, it takes an additional minute for Army staff to enter the current “state of the weather” and to query WIMS for the indices calculated from that hourly, type “S” (special) observation. Per NFDRS standards, fuels may be wet flagged, or state of the weather may be set to 5, 6, or 7 only when it is raining over the entire valley, or when the 10-hour fuel moisture reading at all three Makua stations is 20 percent or higher as a result of recent rain. Heavy dew is unusual at Makua. The hourly “state of the weather” observations and calculated indices are archived by WIMS and can be viewed by all interagency WIMS users. The 10:58 a.m. weather reading is displayed in WIMS as observation time “10.” Weapons restrictions are summarized in Table PD 2. Hourly fire danger ratings are viewed by Range Control staff, and notifications of weapons restrictions are made in such a way that it ensures that no detonations of restricted weapons occur after 15 minutes after the hour. For example, if the burning index, calculated in WIMS from the weather sample taken at 10:58 am is in the Red, no weapon or detonation will occur any later than 11:15 am. If the WIMS system is not maintained properly and operating so that the burning index can be calculated by WIMS, no live fire, blanks, or demolitions will be conducted at Makua. There is no acceptable alternative way to calculate the burning index other than WIMS. If the weather station does not transmit a particular hour’s weather data, including 10-minute average wind speed, via the Automated Sorting, Conversion and Distribution System (ASCADS http://www.fs.fed.us/raws/book/ascads/) to WIMS, the fire danger will be assumed to be in the Red and range restrictions will be applied accordingly. Instantaneous query of station weather readings or use of algorithms or FireFamily Plus or WeatherPro to fill in for missing data is not sufficient to calculate the hourly burning index for range use. To reduce the station's down time, which results from an instrument or data logger being out of service, the Army may maintain a full set of replacement parts, including the data logger for the Makua Range weather station. The Wildland Fire Management Officer is responsible for ensuring the weather station and WIMS is maintained, operating, and applied properly and that inputs are being made correctly. The NFDRS fuel model will not be changed, weapons restrictions will not be changed, a station will not be "greened up" in WIMS more frequently than once each year and no "green up" date will be within nine months of the previous "green up" date without the written approval of the Service Field Supervisor.

3.9 Critical Habitat Restoration

If any area of plant critical habitat is burned, the Army will restore it to its pre-fire percent cover of plant species. Burned plant critical habitat restoration work will likely require erosion control, outplanting of native understory and overstory plants, and intensive weed control. Because the Army's greenhouse facilities are limited, a contractor may need to be hired to propagate common native plants, from appropriate founders, for outplanting in burned areas. Restoration may occur on steep slopes where rappelling will be necessary. A successful weed control program will be instituted immediately following the fire. At no time following an Army-caused fire in plant critical habitat, will the percent cover of any non-native plant species be higher than the pre-fire cover of that plant species. Pre-fire cover will be determined based on the most recent vegetation map, or on-site photographs or vegetation monitoring data available. The Army will provide the Service with a post-fire revegetation plan and annual updates on the status of restoration of the burned area. The timeline for complete vegetation restoration is site specific, but it is anticipated that pre-fire percent cover of species will take approximately 10 years to accomplish. Some areas may require weed control for a longer period of time.

If any area of Oahu elepaio critical habitat within the Makua installation boundary is burned in a wildland fire, or if any area of Oahu elepaio critical habitat within the Makua action area is burned as a result of military activities, the Army will work to encourage shrubs to recolonize the site. The Army will herbicide the burned Oahu elepaio critical habit five times per year with an appropriate herbicide to discourage grasses and favor shrub recolonization. If unexploded ordinance is a concern, the herbicide work will be done aerially. The Army will ensure that pre-fire percent cover of grass will be less than or equal to pre-fire grass percent cover at five years post-fire in burned Oahu elepaio critical habitat areas. If, after five years, the site has not recovered its pre-fire percent cover of shrubs and trees, shrub and tree seeding will be done, to augment the grass control in the burned Oahu elepaio critical habitat area. If, after 10 years, the burned Oahu elepaio critical habitat has not returned to its pre-fire overstory cover, the site will be cleared of unexploded ordinance, and shrub and tree propagules will be outplanted on the site. The Army is developing techniques for controlling grass and restoring shrubs in various management units. Native and non-native shrubs are successfully recruiting from seed on sites where guinea grass is controlled in the Lower Ohikilolo and Kaluakauila management units. Elepaio critical habitat areas occupied by non-native shrub and forest species prior to burning will not necessarily be restored to native shrub and forestland.

Implementation of the post-fire revegetation plan or other post-fire emergency actions may not delay or negatively impact implementation of other actions identified in the Makua Implementation Plan. Remediation cannot prevent the Army's ability to implement other Makua Implementation Plan activities.

Researchers from the U.S. Forest Service and the Center for Environmental Management of Military Lands are seeking substantial funding to develop methods to restore guinea grass, molasses grass, and buffel grass slopes to less flammable and eventually native forest vegetation. The Army is developing expertise in guinea grass restoration, through the work being done at the Lower Ohikilolo Management Unit weed control areas. The Army will develop and submit to the landowner and Service for approval a preliminary post-fire restoration plan for critical habitat within one year from the date of this Biological Opinion. The plan will be appended to the Makua Implementation Plan and will include the following: (1) a list of common native species suitable for post-fire restoration by habitat type and a list of approved sources of propagules for common species for each critical habitat unit in the action area, (2) an estimated timeline for various aspects of restoration of burned areas, (3) an estimated budget for outplanting, erosion control, and other management actions associated with restoration, per acre, for each critical habitat unit, and (4) any additional fuel modification recommended to prevent critical habitat loss and associated costs. A more detailed emergency stabilization and restoration plan will be drafted in the event of a fire in designated critical habitat. The emergency stabilization and restoration plan would be completed by the Army within 30 days of the day that the fire is declared out. The emergency stabilization and restoration plan will include the following: (1) a detailed map of the pre-fire vegetation and species composition in the burned area of critical habitat, (2) a detailed fire intensity map of the burned critical habitat area, (3) a high-resolution aerial photograph of the burned critical habitat area, (4) monitoring protocol and high-resolution photographs of the burned critical habitat area taken from the ground, (5) grass control plans to ensure that fire risk does not increase upslope, (6) species being collected and propagated, source of labor for propagule production and outplanting (contract greenhouse or in-house), and (7) budget for first three years. Annual progress updates, including the results of monitoring which indicate the percent cover of grass and other species, during all months, will be submitted to the Service.

3.10 Army Fire Suppression Assistance to State and City and County

Training at Makua is contingent upon the successful augmentation and threat control of endangered species populations within management units outside the Makua installation boundary. The Army has an interest in preventing fires from burning forested areas and areas containing endangered species in the Waianae Mountains (Figure PD 13).

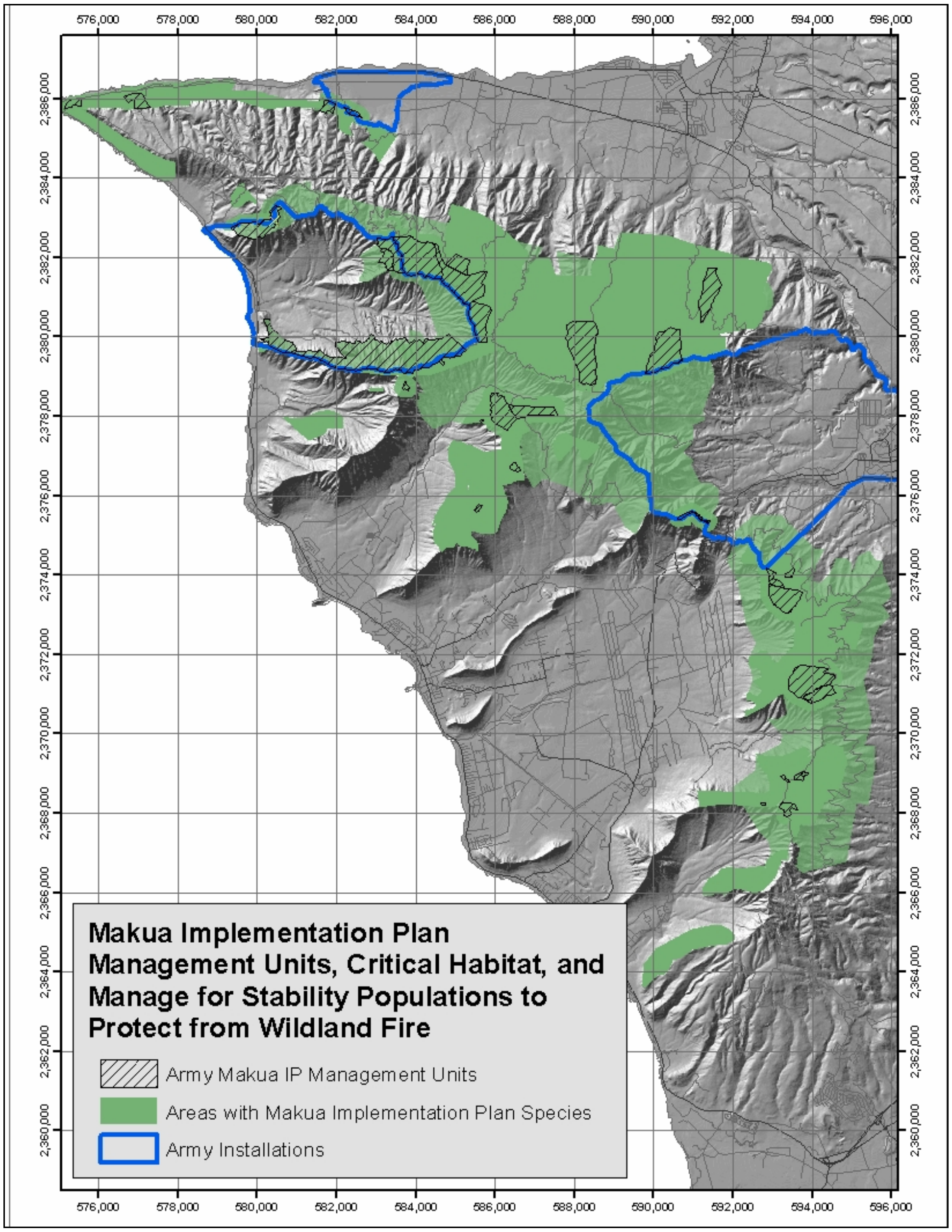


Figure PD 13. Areas of Army fire protection interest which contain listed species and critical habitats. Any fire burning into the areas shaded in green may affect the Army's ability to train at Makua.

Fire suppression and the construction and maintenance of firebreaks and shaded fuelbreaks is necessary to control the threat of fire to the Makua Implementation Plan management units. The Army is working with the interagency wildland fire and land management community to design and implement a system of shaded fuelbreaks and firebreaks to ensure that the management units are protected from fire. Historically the Army has provided firefighter and fire suppression helicopter support to fires threatening these off-site Army interests. As funding and fire suppression resources are available, the Army will continue to assist the other Federal agencies, the State, and the City and County with the suppression of fires which threaten the management units. The use of Army-funded aerial and ground firefighting resources will be authorized on a case-by-case basis within the designated Fire Response Area (Figure PD 14, by the Army Wildland Fire Management Officer, Army Wildland Fire Assistant Fire Management Officer, Department of Public Works Natural Resources Manager, their supervisors in the chain of command, or the Federal Fire Department Unified Command Incident Commander.

Figure PD 14. The Army will maintain a cooperative agreement or Memorandum of Understanding with the State of Hawaii, which will enable the rapid deployment of Army helicopter fire suppression forces and ground firefighting forces to assist with fire suppression activities within the shaded fire response area (Figure 2, Beavers 2007 b).

Full stabilization will require the control of the fire threat to the management units. Many of the units occur in locations of high fire threat. Grass control within 3 to 5 m (10 to 16 ft) of stabilization plant species will ensure their protection from fire. The Army will work with the Service to determine for which sites the full 5 m (16 ft) of grass clearance is necessary.

4. Range Management

The Range and Training Land Program is the program under which the Army conducts range operations and maintenance on lands where Soldiers train in the field. A range is an area that is normally equipped for practice in weapons delivery and/or shooting at targets. The Range and Training Land Program provides a military-centered framework for land management since

Army lands are primarily classified for military use. Range Division implements the Range and Training Land Program, operates firing ranges, and regulates use of training and ordnance impact areas. In addition, Range Division regulates access to training areas and ranges. The key Range and Training Land Program planning device is an installation range development plan, which defines the range and training land requirements. This plan is incorporated into the USARHAW Real Property Master Plan, the Integrated Natural Resources Management Plan, and the Integrated Cultural Resources Management Plan. These efforts, together with the Integrated Training Area Management work plan described below, produce a sound approach for consistent and proactive management of training land while balancing mission, infrastructure, and environmental stewardship.

5. Integrated Training Area Management (ITAM)

The integrated training area management program is the Army's formal strategy for ensuring the sustainable use of training and testing lands. The intent of the ITAM program is to systematically provide uniform training land management capability across Army lands to ensure that the carrying capacity of the training lands is maintained over time. The Army manages its lands to minimize loss of training capabilities to support current and future training and mission requirements. The integration of stewardship principles into training land and conservation management practices ensures that the Army's lands remain viable to support future training and mission requirements. Integrated training area management integrates elements of operational, environmental, master planning, and other programs that identify and assess land use alternatives. The ITAM program also supports sound natural and cultural resources management practices and stewardship of its land assets while sustaining land attributes conducive to supporting training, testing, and other installation missions. These management requirements are as follows: integrate training requirements with training land management; conduct annual monitoring and analysis of resources and ranges; conduct repair and maintenance of training land; enhance mobility, maneuverability, access, and availability in training areas; and train Soldiers in sustainable range awareness to minimize training land damage. These requirements are applicable at all training areas. The following ITAM programs are being implemented at Makua: combat trail maintenance including drainage and erosion control repair; culvert maintenance, embankment repair, hydroseeding of drainage swales; installation of energy dissipaters in swales, sedimentation and detention basins, and erosion control blankets; and archaeological site capping, which includes the use of sandbags to protect sites, and installation of concertina fencing.

6. Environmental Management and Programs

The Army manages two major environmental programs: natural resources management and cultural resources management. The natural resources management program is focused on protecting endangered species. The cultural resources management program is focused on monitoring and protecting areas of traditional importance, as required. The cultural resources management program at USARHAW has a staff that includes a Cultural Resources Manager, four Cultural Resource Specialists, and an Architectural Historian. Managing the resources includes the following tasks: maintaining a cultural site database, including GIS mapping; conducting field survey and site evaluation, location, verification, and monitoring before, during, and after training activities; site preservation; conducting Native Hawaiian consultation; and coordinating with other regulatory agencies. The natural resource program has a staff that includes the following: (1) Natural Resources Manager, (2) Natural Resources Biologist, (3) Monitoring Program Manager, (4) an Makua Implementation Plan and Oahu Implementation Plan Project Manager, (5) Senior Natural Resources Management Coordinator, (6) three Natural Resources Management Coordinators, (7) one Natural Resources Management Coordinator/Rare Plant Program Manager, (8) Horticulturist, (9) Plant Propagation Assistant, (10) Research Specialist, (11) Propagule Management Specialist, (12) Natural Resources Database Specialist, (13) Natural Resources GIS/GPS Technician, (14) Natural Resources Management Specialist, and (15) ten Natural Resources Management Technicians. Managing natural resources includes the following tasks: surveying and mapping rare species and native habitats, determining what protection these species and habitats require, obtaining baseline rare species data in an access and geodatabase, and implementing natural resource protection (rat control, ungulate fencing and control, invasive plant control, alien invertebrate control and habitat restoration).

6.1 Makua Implementation Plan – Stabilization Overview

The concept of stabilization was developed during the 1999 Makua consultation process to offset the adverse impacts of military training to 41 listed species in the Makua action area (as it was then delineated). The Service's 1999 non-jeopardy Biological Opinion was based on certain restrictions to military training, including elimination of tracers and TOWs in the 2001 Supplement to the Opinion, and preparation and implementation of a Wildland Fire Management Plan. In addition, to avoid jeopardizing listed species in the action area, the Army's proposed action included conservation measures to improve the status of certain unstable taxa that occur within the action area. The Army agreed to manage 13 endangered plant taxa that would be minimally impacted by Army training, and to prepare and implement a plan to stabilize 27 target plant taxa and the Oahu tree snail *Achatinella mustelina*. A plant taxon was designated for stabilization if certain numerical demographic criteria were not met and if at least 50 percent of all its individuals were located within the action area. The specific stabilization activities for all 28 target taxa (plants and tree snail) are detailed in the Final Implementation Plan for Makua Military Reservation (Makua Implementation Team 2003). Of the 28 target taxa, 16 plant taxa and the Oahu tree snail are identified for stabilization in this Biological Opinion. In addition, 11 target plant taxa and an additional plant species in the new action area (*Gouania vitifolia*) are identified for expedited stabilization (see Section 6.4, Expedited Stabilization, below). Stabilization target taxa include the following:

Achatinella mustelina
Alectryon macrococcus var. *macrococcus*
Cenchrus agrimonioides var. *agrimonioides*
Chamaesyce celastroides var. *kaenana*
Chamaesyce herbstii
Cyanea grimesiana ssp. *obatae*
Cyanea longiflora
Cyanea superba ssp. *superba*
Cyrtandra dentata
Delissea subcordata
Hesperomannia arbuscula
Hibiscus brackenridgei ssp. *mokuleianus*
Melanthera tenuifolia
Neraudia angulata
Nototrichium humile
Phyllostegia kaalaensis
Plantago princeps var. *princeps*
Tetramolopium filiforme
Pritchardia kaalae
Sanicula mariversa

Dubautia herbstobatae
Flueggea neowawraea
Gouania vitifolia
Hedyotis degeneri var. *degeneri*
Hedyotis parvula
Schiedea kaalae
Schiedea nuttallii
Schiedea obovata
Viola chamissoniana ssp. *chamissoniana*

The methodology for endangered species stabilization was four years in development and involved a Makua Implementation Team composed of experts from the Army, Service, State of Hawaii, Hawaii Natural Heritage Program, The Nature Conservancy of Hawaii, U.S. Geological Survey, University of Hawaii, and Berry Botanic Garden (Portland, Oregon). The Makua Implementation Plan incorporates stabilization standards recommended to the Service by the Hawaii and Pacific Plant Recovery Coordinating Committee in July 1994 and adopted as interim recovery measures in all subsequent plant recovery plans (including Service 1999a, 1998a, 1995a). Based on these recommended standards, the Service determined that a plant taxon may be considered stabilized when all of the following conditions are met: (1) all populations are naturally reproducing, (2) at least three populations each have a minimum number of mature, reproducing individuals (25 for long-lived perennials, 50 for short-lived perennials, and 100 for annuals), (3) all major threats have been controlled, (4) each population is fully represented in an *ex situ* collection (not naturally occurring *in situ* [in the wild]), and (5) fulfillment of genetic storage goals.

Stabilizing a taxon requires maintaining enough populations to ensure long-term viability, and this is the first step toward eventual recovery. Army actions may potentially jeopardize a taxon's continued existence in the wild if numbers in the action area decline to such a level that the entire taxon falls below stability throughout its range (Makua Implementation Team 2003). Ideally, stability would be based on the minimum viable population size needed for persistence of a taxon over time. However, the demographic information needed to estimate minimum viable population size does not exist for most of the covered taxa. Instead, the Makua Implementation Plan is based on the assumption that demographic and environmental conditions are of greater immediate concern than population size per se. Taxon and habitat management within the population units, rather than attainment of a certain population size (e.g., minimum viable population), is considered more likely to increase the probability of population stability in the short term (Schemske et al 1994; Makua Implementation Team 2003).

Many of the stabilization actions for improving the baseline status of target taxa depend on how "population" is defined. Identifying the individuals that comprise a given population is often difficult owing to the lack of basic biological information for most endangered Hawaiian plants. Therefore, the term "population unit" is used as the fundamental geographic and demographic unit of the Makua Implementation Plan Addendum. Population units are defined according to geographic separation and the presence of barriers to dispersal and gene flow. Population units consist of individuals of a taxon at discrete sites, which are separated from other individuals of the taxon by topographic barriers or habitat discontinuities, or that occur more than 1,000 m (3,280 ft) apart (Makua Implementation Team 2003). Thus, a population unit is a manageable grouping of plants that may or may not be a viable population (Hawaii and Pacific Rare Plant Recovery Coordinating Committee 2007). The population units of each target taxon are described in the Makua Implementation Plan (Makua Implementation Team 2003).

Stabilization criteria for plant taxa in the Makua Implementation Plan are defined according to the Hawaii and Pacific Plant Recovery Coordinating Committee recommendations described above. In addition, two population units must be managed for stability outside the action area's high fire risk zone. If two population units are designated for stabilization within the action area, one of them must be within the high fire risk zone. The fire risk zones delineated in previous Service Biological Opinions for Makua and used for development of the Makua Implementation Plan differ from those evaluated in this opinion (see General Effects). Nonetheless, the general criteria for designating population units to be managed for stability still apply to the current proposed action and the current action area, except as modified in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a).

The Makua Implementation Plan outlined a sequenced approach of actions to be implemented over 33 years to achieve stabilization of the target taxa. Specific biological criteria to evaluate success (e.g., minimum viable population size for each taxon) could not be predicted due to lack of demographic and genetic data. Therefore, the Service originally intended to assess success in the short-term by verifying the Army's implementation of management actions according to a schedule stipulated in the Makua Implementation Plan. However, the Makua Implementation Team recognized that delaying certain actions would adversely affect some population units and perhaps significantly reduce the likelihood of successful stabilization. Therefore, this Biological Opinion includes expedited stabilization measures to protect those plant taxa most at risk from training-related wildfire while management for long-term stabilization is being implemented as outlined in the Makua Implementation Plan (see Expedited Stabilization below).

Stabilization strategies include protection of existing population units, augmentation (supplementing existing plant populations with additional individuals), reintroduction (reestablishing a population at a location previously occupied by the species), introduction (establishing a plant population where it was previously not known to occur), and translocation (moving plants from an existing location to a new one). For population units that currently meet stabilization goals for numbers and reproductive success, management may be limited to protecting the plants and controlling threats in their surrounding habitat. For population units that do not meet stabilization criteria for minimum plant numbers, augmentation or reintroduction may be necessary to buffer against the effects of environmental, demographic, and genetic stochasticity in small populations. To achieve this, full genetic representation in *ex situ* collections (such as propagation facilities, seed storage banks, and botanical gardens) will be required for many, if not all, of the existing *in situ* (naturally occurring) population units.

For the Oahu tree snail *Achatinella mustelina*, genetically similar populations are designated as "evolutionarily significant units" based on assessment of intra-population genetic divergence. The results of genetic analyses conducted since completion of the Makua Implementation Plan indicate the presence of six evolutionarily significant units, two of which are comprised of two habitat "eco-types" (Holland and Hadfield 2004). Based on this new data, the Army will implement actions to stabilize eight *A. mustelina* field populations that are geographically spread throughout the Waianae Mountains to protect the maximum genetic diversity of the species. Stability criteria for *A. mustelina* are defined as at least 300 snails in each evolutionarily significant unit, maintenance of captive populations for each recognized evolutionarily significant unit, and control of all threats at each managed field location. Field locations are defined in the Makua Implementation Plan.

The goal of the Makua Implementation Plan is to stabilize species that otherwise would be jeopardized by military training in the Makua action area. Stability is not synonymous with recovery (i.e., delisting) (Makua Implementation Team 2003). Owing to limited knowledge of the life history requirements for short-term and long-term survival of endangered plants, Service recovery plans specify interim objectives to recovery that involve stabilization of all existing populations (Service 1999b, 1998 a). Sustaining a population unit at the minimum number of reproducing individuals for stability over the short-term can prevent extirpation by ensuring adequate regeneration. Recruitment of younger individuals into subsequent generations of mature, reproducing plants likely will improve a species' probability of survival. Stabilization alone, however, is inadequate over the long-term to achieve full recovery.

The Makua Implementation Plan incorporates the stabilization objectives outlined in Service recovery plans, and is based on conservation actions recommended for recovery. These actions include fencing all known occurrences; controlling non-native ungulates and plants; augmenting existing occurrences and establishing new ones; protecting occurrences from fire; investigating and implementing methods to control non-native slugs, snails, and insects; maintaining *ex situ* collections; and conducting research on pollinators. Numerical criteria for stabilizing a species are less stringent than those recovering (delisting) a species. Recovery criteria require eight to ten populations of 100 mature, reproducing individuals for long-lived perennials, 300 for short-lived perennials, and 500 for annuals (Service 1999a, 1998a, 1997). Stabilization approximates conditions necessary for survival of a species in the wild and is a prerequisite for recovery. Achieving stabilization, therefore, will enable the Army to comply with the Endangered Species Act jeopardy standard by avoiding or minimizing actions that will reduce appreciably a species' likelihood of both survival and recovery in the wild. Although recovery is the ideal, the Army is only expected to stabilize, not fully recover, species in order to avoid the likelihood of jeopardy resulting from military activities.

A population unit designated as "manage for stability" usually occurs in habitat that is relatively intact or restorable, and where threat control is expected to encourage natural regeneration. The Makua Implementation Plan designated, on average, six population units to be managed for stability for each target taxon, with the intent that at least three of the population units would be successful. Thus, monitoring to determine the response of target taxa to management is critical to achieving stability. If the number of individuals in a population unit declines, monitoring allows the Makua Implementation Team to adapt management actions to deal with the likely causes of decline through additional threat control actions and/or augmentation/reintroduction. Threat management includes control, as needed, of ungulates, weeds, rats, slugs, and insects. Ungulate control typically requires construction and maintenance of fenced exclosures. Within fenced population units, aggressive control of understory weeds is required within a 2-m (6.6-ft) radius of target taxon individuals. Long-term threat management goals include eradication of incipient invasive weeds at the population unit scale (within a 50-m (164-ft) radius of target plants). For other weeds, long-term weed control goals require eradication of up to 25 percent of existing weed cover in the proximity of population units and up to 50 percent total weed cover across the management unit or subunit.

A population unit designated as "manage for genetic storage collection" generally contains few individuals of the target taxon and poor conditions for regeneration or habitat rehabilitation. The purpose of genetic storage is to achieve adequate, appropriate *ex situ* storage of genetic material as insurance against loss of a population unit or reintroduced individuals. Options include seed storage, *in vitro* tissue storage through micropropagation, and living collections of cultivated plants in greenhouses and botanical gardens. For each population unit, at least 50 seeds will be collected from each of 50 individuals (but no more than 20 percent of all seeds produced each year), or three clones will be maintained in micropropagation, or three cultivated plants will be maintained in the greenhouse. For population units with fewer than 10 individuals, at least 20 percent of all seeds produced will be collected during the initial years, until sufficient material is collected for storage and augmentation/reintroduction needs. For species that can be propagated vegetatively, cuttings will be collected from non-fruiting plants. For very small population units of fewer than five individuals, each individual also will be represented as a living collection, typically as a potted plant in a greenhouse.

6.2 Makua Implementation Plan Addendum

For this consultation, the Army revised the Makua Implementation Plan to address the logistical difficulties of off-site conservation management and to reduce the cost of species stabilization actions. The Army's proposed Makua Implementation Plan Addendum for Makua Military Reservation outlines actions to attain three stabilized, naturally reproducing population units for each target taxon (U.S. Army Garrison Hawaii 2005a). Instead of managing up to six population units per taxon to ensure that at least three eventually are stabilized, as recommended by the Makua Implementation Plan, the Makua Implementation Plan Addendum focuses management efforts on the three (or in a few cases, four) most viable prospects for success. Four population units will be managed for stability for species present in the action area of both Makua and Schofield Barracks Military Reservation, for certain species occurring in the high fire risk zone of the Makua action area, and for certain species for which stabilization will rely greatly on reintroduction. Accordingly, the Makua Implementation Plan Addendum addresses management for approximately 92 plant population units, instead of the 188 plant population units included for management in the Makua Implementation Plan. The purpose of additional population units in the Makua Implementation Plan was to provide future "back-ups" if any population units within the action area were extirpated before stabilization could be achieved; this option is no longer maintained under the Makua Implementation Plan Addendum. In addition, under the Makua Implementation Plan Addendum, the Army will focus the collection of genetic material primarily on those species that are most threatened by fire and that exist in very low numbers, with the purpose of supporting augmentation of population units and ensuring the availability of genetic material for future efforts. The Makua Implementation Plan provided for collection of genetic material from all *in situ* population units.

The projected time frame for the Makua Implementation Plan was 33 years; the projected time frame for the Addendum is 20 years. Like the Makua Implementation Plan, the Makua Implementation Plan Addendum includes population unit actions for each stabilization taxon and management unit actions to improve habitat on an ecosystem basis, as well as an implementation schedule and budget. The Army will provide an annual progress report that lists and describes the species specific management actions completed to date as they relate to the actions identified in the Makua Implementation Plan. This report will be organized in a manner agreed upon by the Service to ensure that the progress meets the goals of the consultation. The Makua Implementation Team will conduct an annual assessment of management results by reviewing monitoring data to determine the Army's progress toward achieving stabilization of the target taxa within a reasonable time frame. The annual review also will allow for modification of stabilization strategies as needed, using an adaptive management approach.

6.3 Management Units

In addition to designating population units for stabilization management of target taxa, the Makua Implementation Plan also designated larger management units for ecosystem-level habitat management and threat control. The geographic scope of the Makua Implementation Plan included the entire action area (as then delineated) plus portions of the natural geographic ranges of the target taxa considered necessary to achieve their stability. Thirty-one management units were designated, based on the location of *in situ* population units and potential reintroduction areas for the target taxa. Together the management units covered 2,571 ha (6,353 ac) and were intended to define a large, contiguous landscape of habitat for the target taxa. In general, the management units encompassed most of the population units to be managed for stability or reintroduced for stability. Most management units would be fenced, and ungulates and other threats, such as non-native invasive plants, would be controlled. These actions also would benefit critical habitat for endangered plants and the Oahu elepaio within the management units.

The Makua Implementation Plan Addendum retains the basic implementation program of the Makua Implementation Plan while reducing the number of population units managed for stabilization, and the number and area of management units managed for ecosystem restoration. Six management units were eliminated and most of the remaining ones were reduced in area. The Makua Implementation Plan Addendum identifies 23 "priority management units" encompassing approximately 934 ha (2,307 ac) of "priority habitat." This area represents a 64 percent reduction from the area designated for the 31 management units in the Makua Implementation Plan. By reducing the number of population units managed for stability, and the number and area of management units to control ecosystem-level threats, the Army expects to reduce average annual costs to approximately $3.3 million instead of $8 million needed to implement the Makua Implementation Plan (U.S. Army Garrison 2005a). Chapter 2 of the Makua Implementation Plan Addendum describes the conservation actions the Army will implement within each management unit, and Chapter 3 describes the modified management units.

The 23 priority management units are located in the Waianae Mountains and Koolau Mountains of Oahu where the most important wild populations of the target taxa occur (see Figure 1). These management units are located on lands owned by the Army, State of Hawaii, City and County of Honolulu Board of Water Supply, and private entities. Cooperation through memoranda of agreement with landowners will be required before the Army can initiate management actions at non-Army sites. Eight management units are located on Army lands or within the Makua action area: Kahanahaiki, Kaluakauila, Lower Ohikilolo, and Ohikilolo are located on Makua Military Reservation; the Keaau and Makaha management unit is located on State lands within the action area; and the Pahole, Upper Kapuna, and West Makaleha management units are located on State lands that are partially within the action area. Some of the management units on non-Army lands, such as Pahole (which is operated by the State of Hawaii as a Natural Area Reserve) and Ekahanui, Kaluaa and Waieli, and Palikea (which are operated by The Nature Conservancy of Hawaii as part of Honouliuli Preserve), are already being managed to varying degrees to protect sensitive species.

Table PD 6 lists the 23 priority management units identified in the Makua Implementation Plan Addendum and how they have been modified from those designated in the Makua Implementation Plan. Table PD 7 lists seven management units or subunits that are fenced, 22 management units or subunits that are planned to be fenced by 2015, and eight management units or subunits that will not be fenced. Dates of future construction are subject to change. Thus, about 32.8 percent of the total proposed management unit area is now fenced, 63.6 percent will be fenced over the next 10 years, and 3.6 percent will not be fenced. Ungulate control, where necessary, includes a combination of monitoring, fencing, hunting, and snaring. Weed control is conducted primarily in the most intact native habitats, for example within the seven management units with ecosystem-level fences and at five unfenced sites where ungulates are not a threat owing to the presence of topographical barriers. In general, weed control effort is prioritized to areas of high native plant cover, around target taxa individuals, and at potential augmentation/reintroduction sites. Over the last two years, Army Natural Resources Staff has established “weed control areas” in the management units and have begun to standardize weed monitoring and reporting (U.S. Army Garrison 2006c). Most of the weed control areas contain population units of target stabilization taxa and surrounding native habitat, and weeds within a 15-m (50-ft) radius around the population units are removed directly around the target plants (U.S. Army Garrison 2005c).

Other conservation management actions the Army is implementing to varying degrees in the management units include rat control, propagule collection, outplanting of target plant taxa, research on slug and insect control, and maintenance of two small fenced exclosures to protect Oahu tree snails. In addition, fire management plans for the management units have been completed. Actions including grass clearance from within 3 to 5 m (10 to 16 ft) of stabilization plants, and Army fire suppression assistance on fires threatening management units will be completed in order for the fire threat to be considered to be adequately controlled by the Army. Additional fuelbreaks, firebreaks, or other fire protection systems necessary to ensure that the habitat in the management units is not burned by a wildland fire, will be a necessary stabilization action. Army annual reports describe all ongoing actions implemented for conservation of target taxa within population units and management units (U.S. Army Garrison 2004a, 2005c, 2006c). Army actions within action area management units are briefly described below (M. Mansker, U.S. Army Garrison, pers. comm. 2006).

The Kahanahaiki, Kaluakauila, Lower Ohikilolo, and Ohikilolo management units are located on Makua that is generally considered goat-free, but pigs still have access to some areas. The Kahanahaiki Subunit I Management Unit is fenced, and both pigs and goats have been removed. Subunit II is not fenced but snaring reduces pig impacts on native communities in that subunit and on the subunit I fence. Management actions within the fenced Kahanahaiki subunit I include outplanting of target taxa, Oahu tree snail management, rat and weed control, monitoring of plants and tree snails, propagule collection, and research on slug damage and control measures.

Table PD 6. Priority Management Units in Makua Action Area (U.S. Army Garrison 2005a, Makua Implementation Team 2003).

Management Units (Addendum)	**Acres**	**Management Units (Makua Implementation Plan)**	**Acres**
1. East Makaleha	231	1. Central and East Makaleha	823
2. Ekahanui	203	2. Ekahanui	221
3. Haili to Kealia	30	3. Haili to Kawaihapai	161
		4. Huliwai (deleted)	118
		5. Kaahole to Paaiki (Kauai; deleted)	468
4. Kaena	52	6. Kaena and Keawaulu	103
5. Kahanahaiki	94	7. Kahanahaiki	97
6. Kaimuhole	100	8. Alaiheihe to Palikea Gulch	619
7. Kaluaa and Waieli	127	9. Kaluaa and Waieli	342
8. Kaluakauila	104	10. Kaluakauila	152
9. Kamaileunu	5	11. Kamaileunu	86
		12. Kauaopuu (deleted)	19
		13. Kaumoku Nui (deleted)	213
		14. Kawaiiki (Koolau; deleted)	44
10. Keaau and Makaha	5	15. Keaau and Makaha	5
11. Lower Kahana (Koolau; new)	3		
		16. Lower Kahanahaiki (deleted)	32
		17. Lower Kapuna (deleted)	266
12. Lower Ohikilolo	70	18. Lower Ohikilolo	70
13. Lower Opaeula (Koolau)	17	19. Lower Opaeula (Koolau)	65
14. Makaha	162	20. Makaha	172
15. Manuwai	166	21. Mt. Kaala Natural Area Reserve	166
		22. Mohiakea (deleted)	19
16. Ohikilolo	200	23. Ohikilolo	578
17. Pahole	215	24. Pahole	215
18. Palikea	45	25. Palikea	127
19. Puu Kumakalii	28	26. Puu Kumakalii	28
20. Upper Kapuna	182	27. Upper Kapuna	225
		28. Upper Keaau (deleted)	10
21. Waianae Kai	9	29. Waianae Kai	125
22. Waiawa (Koolau)	124	30. Waiawa (Koolau)	75
23. West Makaleha	93	31. West Makaleha	255
Total	**2,307**		**6,353**

Table PD 7. Fencing Status in Management Units, Makua Action Area (U.S. Army Garrison 2005b, 2005c).

Existing Fence	**Acres**	**Fence Construction (target year)**	**Acres**	**No Plans to Fence**	**Acres**
Ekahanui Subunit I	44	East Makaleha (2008)	231	Haili to Kealia Subunit I	20
Kahanahaiki Subunit I	63	Ekahanui Subunit II (2007)	159	Haili to Kealia Subunit II	10
Kaluaa and Waiele Subunit III	107	Kahanahaiki Subunit II (2008)	31	Kaena Subunit I	16
Kaluakauila (UA1)	104	Kaimuhole (2010)-not an option right now	100	Kaena Subunit II	36
Lower Ohikilolo (UA1)	70	Kaluaa and Waiele Subunit IIB (2015)	11	Palikea Subunit IV	9
Ohikilolo (Ridgeline)	162	Kamaileunu (2007 or 2008)	2	Palikea Subunit V	4
Pahole	215	Keaau and Makaha (2009)	5	Puu Kumakalii	28
Kaluaa and Waieli Subunits IIA + IIC	24	Lower Kahana (2014)	3		
		Lower Opaeula (2007)	17		
		Makaha Subunit I (2007)	96		
		Makaha Subunit II (2009)	66		
		Makaha Subunit III (2009)	1		
		Manuwai (2012)	166		
		Ohikilolo (Lower Makua) (2011)	38		
		Palikea Subunit IA (2009)	21		
		Palikea Subunit IB (2009)	11		
		Upper Kapuna Subunit I (2006-2007)	182		
		Upper Kapuna Subunits II, III, IV (2008-2009)	42		
		Waianae Kai (2011)	9		
		Waiawa (2013)	124		
		West Makaleha (2009 (estimated))	93		
Total	**757**		**1467**		**83**

The Kaluakauila Management Unit is fenced and ungulate-free. Management actions include weed control, alien grass control for fuels management, outplanting of native plants, and rare plant surveys.

The Lower Ohikilolo and Ohikilolo management units are bordered by the Ohikilolo perimeter ridgeline fence and are goat-free. The Lower Ohikilolo Management Unit contains a small strategic fence to protect an occurrence of *Melanthera tenuifolia*. Native plants predominate in this management unit owing to intensive control of alien grasses around occurrences of *Chamaesyce celastroides* var. *kaenana*, *Hibiscus brackenridgei* ssp. *mokuleianus*, and *Spermolepis hawaiiensis* (a listed species that is not being managed for stability). In the Ohikilolo Management Unit, actions include weed control, rat control around certain rare plants, propagule collection and outplanting of target taxa, Oahu tree snail management within a small fenced exclosure, and snail habitat restoration through outplanting of common, native host trees. This management unit also contains small fences around occurrences of *Neraudia angulata* and *Pritchardia kaalae*. Lower portions of the Ohikilolo Management Unit are inaccessible to Army Natural Resources staff due to the presence of unexploded ordnance.

The Pahole, Upper Kapuna, and West Makaleha management units are located on State lands that are partially within the action area; the Keaau and Makaha Management Unit is entirely within the action area. Most conservation actions in these management units are implemented by State personnel, with varying degrees of assistance from Army Natural Resources Staff. The Pahole Management Unit is fenced and ungulate-free; management actions include some weed control, outplanting, and propagule collection. In the Upper Kapuna Management Unit, the State is working on fencing subunit I and has built two small fences around reintroduced occurrences of *Phyllostegia kaalaensis*. The Army also assists with goat monitoring and removal and weed control, and will assist in future construction of fences around the three other Upper Kapuna subunits. The West Makaleha Management Unit is scheduled for fencing in 2006 or 2007 and already contains two small fences protecting occurrences of *Cyanea grimesiana* ssp. *obatae* and *Schiedea obovata*. The Army assists the State with goat monitoring and control, weed control, outplanting, and propagule collection. The Keaau and Makaha Management Unit is located on non-Federal lands within the State Keaau Game Management Area and will be fenced in 2009.

The Makaha Management Unit is located on city/county lands outside the action area and is critical for reintroduction of stabilization population units of several target taxa. Fence construction is currently being completed at Makaha subunit I and for the two other subunits in 2009. The Army currently assists the Board of Water Supply with rare plant surveys, intensive weed control, rat control in Oahu elepaio territories, and monitoring experiments for invasive plant control. The Army also funds a full-time field employee to assist The Nature Conservancy of Hawaii in conservation management of target taxa in the privately owned Honouliuli Preserve, which contains the Ekahanui, Kaluaa and Waieli, and Palikea management units.

6.4 Expedited Stabilization

The Makua Implementation Team recognized that full stabilization likely would not be achieved for the original 27 target plant taxa within the 33 years projected by the Makua Makua Implementation Plan. The Army's proposed Makua Implementation Plan Addendum covers a 20-year planning horizon that likewise does not guarantee target taxa will be stabilized within a specified timeframe. The Service originally intended to assess the success of stabilization in the short term by verifying the Army's implementation of management actions according to the schedule outlined in the Makua Implementation Plan. However, certain taxa at greatest risk from training impacts (i.e., those with very low numbers and/or those located within the high fire risk zone) were intended to receive all needed management during the first phase of implementation (years 1 to 13) (Makua Implementation Team 2003). The Army's proposed action for this Biological Opinion takes a similar approach by incorporating an expedited stabilization plan for 12 taxa identified as most at-risk from training-related wildfire in the action area. Stabilization plans for 11 of these at-risk taxa are already included in the Makua Implementation Plan and Makua Implementation Plan Addendum; *Gouania vitifolia* will be added due to its presence in the new action area for this consultation. In addition to expedited stabilization of these 12 at-risk taxa, the Army will continue to manage for full stabilization of all target taxa as outlined in the Makua Implementation Plan Addendum. The 12 target taxa identified for expedited stabilization include the following:

Chamaesyce herbsti
Cyanea grimesiana ssp. *obatae*
Cyanea longiflora
Cyanea superba ssp. *superba*
Delissea subcordata
Gouania vitifolia
Hibiscus brackenridgei ssp. *mokuleianus*
Neraudia angulata
Phyllostegia kaalaensis
Sanicula mariversa
Schiedea nutttallii
Schiedea obovata

Expedited implementation of a modified stabilization plan is intended to protect the 12 at-risk taxa from jeopardy over the next 10 years while actions toward full stabilization for all target taxa are being implemented. The purpose of expedited stabilization is to ensure that stabilized, or near-stabilized, population units are established both inside and outside the action area as quickly as possible. Stabilization of population units outside the action area where they will not be at risk of training-related wildfire is particularly critical. The expedited stabilization plan for the 12 at-risk taxa modifies certain priorities and numerical criteria for conservation actions outlined in the Makua Implementation Plan Addendum. Until these at-risk species have attained expedited, modified stabilization levels, the Army will not fire tracers, 2.75-caliber rockets, or Javelin missiles, or implement Column D weapons restrictions. In addition, other weapons systems and munitions will be used only in accordance with NFDRS and live fuel moisture conditions, and with the adequate fire suppression staffing specified in the Project Description evaluated for this opinion (see Table PD 2).

After attainment of expedited stabilization for the 12 at-risk taxa, the Army may begin training with the weapons systems and munitions cited above (note that full stabilization of all 12 at-risk taxa and all 16 stabilization target taxa are required before the Army may begin training with TOW missiles). However, certain restrictions will be imposed on continued use of those weapons systems and munitions if a fire is ignited outside the firebreak road or spreads outside the firebreak road from an ignition within the training impact area. If such a fire occurs, the Army will immediately cease all live-fire training and focus on suppressing the fire. The Army will cease using the weaponry that caused the fire and will meet with the Service within 10 calendar days to discuss the incident. If the Service and Army agree that the fire ignition and suppression actions occurred as anticipated, training with that particular weapon or munition may resume.

Expedited implementation of a modified stabilization plan for the 12 at-risk taxa will be realized over the next 10 years through conservation measures summarized in Tables PD 8 and 9. The expedited actions are intended to increase the baselines of the 12 taxa inside and outside of the action area as rapidly as possible. In general, these expedited stabilization measures are based on continuing management of all *in situ* population units for all target taxa identified as "manage for stability" in the Makua Implementation Plan Addendum, with prioritization of activities to stabilize population units of at-risk taxa inside and outside the action area. For some at-risk taxa, this will require initiating establishment of new population units through reintroductions on State, city/county, or private lands on an accelerated schedule. Meanwhile, the Army will continue to implement activities intended to achieve full stabilization of all target taxa according to the schedule outlined in the Makua Implementation Plan Addendum. The Army and the Service will annually review monitoring data to assess the Army's progress towards achieving full stabilization of all 29 target taxa (including 16 target plant taxa, 12 at-risk plant taxa, and the Oahu tree snail *Achatinella mustelina*). The annual review also will allow for modification of stabilization actions as needed, using an adaptive management approach.

For all stabilization population units of at-risk taxa (at least three per taxon), the Army will ensure that adequate numbers of individuals are outplanted and maintained to conform to modified numerical criteria for stability. For example, if a taxon's numerical stabilization goal is 50 mature, reproducing individuals per population unit, the Army will establish and continue to maintain *in situ* at least 50 individuals of outplanting size per stabilization population unit, regardless of reproductive maturity. These numerical goals must be maintained or increased for at least two years before the designated weapons systems and munitions can be used. All outplanted plants will be of sufficient size and vigor to survive in the wild. The ability to maintain numerical criteria and protect plants in the wild will require fencing some of the management units encompassing the expedited population units as soon as possible. Expedited stabilization of certain species vulnerable to infestation by slugs and insects also will require investigation of appropriate pest control measures.

Expedited stabilization also will require measures be taken to better ensure that the stabilization population units are protected from the risk of training-related wildfire. Expedited stabilization population units not protected by intact vegetation (i.e., 200 m (656 ft) of shrub/forest), or strategically placed firebreaks or fuelbreaks will be protected with localized fuel treatments around individual plants. Three to five m (9.8 to 16.4 ft) of fuel clearance will be completed around individual expedited stabilization plants that are not otherwise protected by fire protection systems. Expedited stabilization plants occurring within the potential ignition areas of the Javelin or TOW will also receive this localized fuel treatment. Plant level fuel management may be waived on a case-by case basis for plants occurring on cliffs where fuels are discontinuous, with the approval of the Service. Management unit level fuelbreak and firebreak completion is not an expedited stabilization measure, but will be completed in order to meet full stabilization implementation habitat protection goals. Once these fuels treatments are completed by the Army and expedited stabilization is completed for the 12 at-risk taxa, the Army may begin training with tracers and long-range weapons. Accordingly, an important component of the expedited, modified stabilization plan for the 12 at-risk taxa is annual monitoring to ensure survival of the minimum number of plants in the stabilization population units. Once all stabilization population units are established at expedited, modified goals for the 12 at-risk taxa, the Army will continue to implement standard conservation management of the population units and the management units in which they are located in order to attain full stabilization, as outlined in the Makua Implementation Plan Addendum.

The Army estimates that expedited stabilization can be achieved, with adequate funding, within 10 to 15 years for most of the 12 at-risk taxa. One species with periodic dormancy, *Sanicula mariversa*, may require a longer timeline because preliminary monitoring must be conducted and evaluated to determine appropriate goals and techniques for stabilization. Successful achievement of expedited, modified stabilization for these species will not occur without full funding for the Makua Implementation Plan Addendum, the Wildland Fire Management Plan, and the wildland fire suppression and fuels management sections of this Project Description. The Service expects the Army will guarantee funding for these features to ensure expedited stabilization for the 12 at-risk taxa, so that training with the proposed weapons systems and munitions can take place at Makua.

Table PD 8. Conservation Activities in Management Units (U.S. Army Garrison 2005 a, b).

Management Unit	Area (acres)	Fence Schedule	Ungulate Control Status	Weed Control Areas (acres)
East Makaleha	231	Construct in 2008	Limited goat control in adjacent areas	None
Ekahanui	203	Subunit I (44 acres) fenced	Subunit I ungulate free	9.8 ac
		Subunit II (159 ac) construct in 2007		
		Small PU fences for *Delissea subcordata , Schiedea kaalae*		
Haili to Kealia	30	None	None	3.3 ac
Kaena	52	None	None	3.01 ac
Kahanahaiki	94	Subunit I (63 ac) fenced	Subunit I ungulate free	48.12 ac
		Subunit II (31 ac) construct in 2008		
Kaimuhole	100	Construct in 2010	None	None
Kaluaa and Waieli	127	Subunit IIA (9 ac) construct in 2006	Subunit III ungulate free	2.9 ac
		Subunit IIB (11 ac) construct 2015		
		Subunit IIC (8 ac) construct 2005		
		Subunit III (99 ac) fenced		
Kaluakauila	104	Fenced	Ungulate free	11.92 ac
Kamaileunu	5	None	None	None
Keaau and Makaha	5	Construct in 2009	None	None
Lower Kahana	3	Construct in 2014	None	None
Lower Ohikilolo	70	Fenced	Ungulate free	7.99
Lower Opaeula	17	Construct in 2007	None	None
Makaha	162	Subunit I (96 ac) construct in 2006	None	22.38 ac
		Subunit II (66 ac) construct in 2009		
		Subunit III (1 ac) construct in 2009		
Manuwai	166	Construct 2012	Goats controlled in adjacent areas	None
16. Ohikilolo	200	Majority (162 ac) fenced	Most goats removed	7.43 ac
		Lower Makua (38 ac) construct in 2011		
		Small PU fences for particular species		
17. Pahole	215	Fenced	Ungulate free	32.4 ac
18. Palikea	45	Subunit IA (21 ac) construct in 2009	Pigs controlled in subunits IA and IB	4.61 ac
		Subunit IB (11 ac) construct in 2009		
		Subunit IV (9 ac) none		
		Subunit V (4 ac) none		
		Small PU fences		
19. Puu Kumakalii	28	None	None	None
20. Upper Kapuna	182	Subunit I (182 ac) construct in 2006	None	6.33 ac
		Subunits II, III, IV (42 ac) construct in 2008-2009		
		Small PU fences for *Phyllostegia kaalaensis*		
21. Waianae Kai	9	Construct in 2011	None	None
		Small PU fences for particular species		
22. Waiawa	124	Construct in 2013	None	None
23. West Makaleha	93	Construct in 2006	Goats controlled in adjacent areas	3.3 ac
		Small PU fences for *Schiedea*		

Table PD 9. Conservation Measures for Expedited, Modified Stabilization of 12 At-Risk Taxa at Population Units (PUs) to be Managed for Expedited Stabilization and Management Units (MUs) in which They are Located. (Scientific names of taxa are abbreviated by combining the first three letters of the genus and species names.)

Conservation Measures	**Chaher**	**Cyagri**	**Cyalon**	**Cyasup**	**Delsub**	**Gouvit**	**Hibbra**	**Nerang**	**Phykaa**	**Sanma**	**Schnut**	**Schobo**
Manage 3-4 *in situ* PUs	3	3	3	4	4	3	4	4	3	3	3	3
Attain numerical stability at 1-3 PUs outside action area	2	2	1	3	3	2	3	3	2	1	1	1
Initiate reintroduction of PUs outside action area	2			2		1	1	1	2		1	1
Implement rat, slug, insect control as needed		X	X	X	X		X				X	X
Construct fence												
Upper Kapuna MU West Makaleha MU	X		X	X	X				X		X	
Makaha MU	X	X	X						X			
Other MUs	X			X				X	X		X	X
		X	X	X		X	X	X	X	X		
Control weeds	X	X	X	X	X	X	X	X	X	X	X	X
Implement additional fire management and	X	X	X	X	X	X	XXX	X	X	X	X	X
Obtain cooperative agreements	X	X	X	X	X		X	X	X	X	X	X
Conduct additional monitoring	X	X	X	X	X	X	X	X	X	X	X	X
Conduct population dynamics research										X		
Develop stabilization plan						X						

7. Conservation Measures

Funding:

1) The Makua Implementation Plan Addendum will be fully funded to ensure that all training activities at Makua are in conformance with the Biological Opinion. This funding shall be in place prior to any live-fire training activities occurring at Makua.

2) The Wildland Fire Management Plan will be updated to incorporate the requirements specified by this Biological Opinion, will be fully funded, and all precautions will be followed as outlined in this Opinion for any live-fire training to occur at Makua.

Training:

1) Range operations staff will be fully trained in WIMS and will have a thorough understanding of weapons restrictions based on fire danger, fuels project completion, and locations and status of endangered species at Makua.

2) The Army will not use Kaena Point trail for any training activities.

3) If any Army training-related fire ignites outside of the firebreak road (designated impact area), use of all weapons will cease and the Service will be notified within one hour. The Army will provide the Service with a briefing detailing the cause of the fire, forecasted and actual fire weather, forecasted and actual fire behavior, and predicted and actual helicopter productivity. The briefing will include video or other fire behavior and helicopter productivity data taken during the first hour of fire suppression. The range will be reopened for training only after the Service has determined that the Army actions that contributed to the fire and resulted in its suppression were conducted in accordance with the requirements of the Biological Opinion. If the Army is unable to identify and/or correct the problem, then further use of that weaponry will be prohibited until full stabilization, as outlined in the Makua Implementation Plan Addendum, is achieved.

4) If a prescribed burn or military training fire burns any portion of a management unit or designated critical habitat, the Army will meet with the Service to determine if there is a need to strengthen the fuelbreak and firebreak system, increase weapon restrictions, or augment fire suppression staffing to prevent a similar fire in the future.

5) Smoking is permitted only in the administrative bivouac site or near the Makua Range Control Building but no further than the gate into the actual valley.

6) All ordnance fired at Makua will be aimed to fall within the south firebreak road.

7) Targets will be placed to minimize the possibility of ammunition going outside the firebreak road.

8) No live-fire training (of any kind) will be allowed when fire danger is red (high).

9) C-Ridge will not be used for any training purpose.

10) No illumination rounds will be permitted at Makua.

11) All live-fire training will take place on existing training ranges (southern lobe impact area) and will not land outside of the surface danger zones.

12) Open fires are not allowed anywhere at Makua including bivouac sites.

13) There will be no off-road vehicular activity at Makua.

14) Before night training at Makua is conducted, helicopters must be authorized to be used for fighting night fire suppression.

Kuaokala Trail Conservation Measures:

1) Smoking will not be allowed during road or trail marches.

2) Soldiers would be restricted to the established trail or roads when on marches, and marching formation would conform to the width of the trail.

3) The trail will be surveyed before and after each march by a qualified Natural Resources Staff person capable of determining if there has been damage to the trail and the surrounding flora and fauna that would contribute to species and habitat deterioration. Any such deterioration will be reported to the Service within 48 hours and use of the trail will be suspended until the Army and Service can meet to discuss further conservation measures to prevent future damage.

8. Weapons Used at Makua

Small Arms

Blank Ammunition: There is the potential for hot shell casings to ignite fires close to the firing point during the firing of blank ammunition. Therefore, the range will be staffed by ground fire suppression forces including a NWCG-qualified Incident Commander, two engines, a water tender and standby helicopters. Unlike helicopter staffing requirements for all other weapons under most other conditions, none of the fire suppression helicopters need to be on-site at Makua when blank ammunition is being fired. They will all be assigned to the training, but with a one-hour response time to a fire occurring outside the firebreak road. Flash suppressors and blank adapters will always be used on weapons firing blanks at Makua, preventing hot residue from exiting the muzzle. Blanks will not be fired when live herbaceous fuel moisture is 49 percent or lower, or when the Fire Danger Rating is in the Red.

Ball Ammunition Training: All ball ammunition qualification and demolition training will take place within the current impact area, the southern lobe of the firebreak road. The qualification training involves using small arms (rifles, pistols, machine guns, or shot guns), with .308, .38, .45, or .50-caliber; 5.56, 7.62, or 9 mm; 12 gauge; or 40 mm target practice rounds shooting at either pop-up targets or fixed targets. The fixed firing points are elevated on a two-foot platform to decrease the chance of fire ignition from a muzzle flash or hot casings, and are located in a mowed area.

Small Arms Weapons Mounted on Helicopters: These weapons will not be discharged while the helicopter is outside the south lobe of the firebreak road to ensure that any fire ignited from a hot casing falling from the helicopter starts inside the firebreak road. Tracer fire from helicopters is prohibited.

Demolitions

Demolitions training at Makua will take place at the ordnance impact area and may include a range of activities such as: (1) use of low levels of explosives to destroy wood or steel structures, (2) gaining entry to buildings, (3) placement and detonation of shape charges at the ordnance impact area (shape charges are composed of C4 plastic and would be used as 6.8-kilogram (kg) (15-pound (lb)) charges (80 times a year) and 18-kg (40-lb) charges (36 times a year), and (4) detonation of cratering charges at the ordnance impact area following the detonation of the shape charge (the M039 cratering charge) filled with ammonium nitrate (placed within the hole created by the shape charge). The typical maximum amount of ammonium nitrate that would be used at any one time would be 68 kg (150 lbs) and possibly up to 136 kg (300 lbs). All demolitions training will be conducted in areas of bare ground or exploded within metal drums to reduce the risk of fire.

Special Demolitions and Demolition Munitions: These munitions will be used for specific purposes at Makua such as unexploded ordinance disposal or by Soldiers training to clear mines, breach doors or overcome obstacles. Demolition munitions contain ordnance capabilities and are used to assist the Soldier in battle situations. The only demolitions materials that will be used at Makua are C4, TNT, detonation cord, blasting caps, time fuses, cratering charges, shaped charges, and bangalore torpedoes. Procedures for the safe use of many of these weapons, including explosives such as TNT or composition C4, require use to be limited to excavated demolition pits surrounded by a sand bag barrier. No more than 136 kg (300 lb) net explosive weight will be detonated in any demolition at Makua. To minimize the chance of a fire igniting outside the firebreak road, demolitions will be oriented, when possible, in a way that directs hot gasses or blast fragments toward the interior of the south lobe of the firebreak road.

Unexploded Ordinance Disposal: Unexploded ordinance disposal activities may be conducted within the valley, outside the south lobe of the firebreak road, when live herbaceous fuel moisture, calculated in the WIMS for the Makua Range weather station (number 490301) is 100 percent or higher and the burning index is 20 or lower (fire danger rating Green/Low). Fire suppression ground and helicopter resources will be fully staffed in accordance with the fire suppression staffing guidelines used for live-fire training.

Restrictions
Unexploded ordinance may be detonated at locations 100 m (328 ft) or greater inside the south lobe of the firebreak road and within designated demolition training areas only when the burning index is 20 or lower and when live herbaceous fuel moisture is 60 percent or higher. This will only be allowed after grass has been removed from within 3 m (2 ft) of all *Hibiscus brackenridgei* ssp. *mokuleianus* and *Chamaesyce herbstii* plants within the Lower Ohikilolo Management Unit. Fire suppression helicopter staffing will be assigned to demolitions training

and unexploded ordinance activities in accordance with the helicopter staffing guidelines in Table PD 5.

M79 and M203 Grenade Launchers

Only M79 and M203 grenade launchers will be used at Makua. The maximum range for the M79 and M203 grenade launchers is 400 m (1,312 ft).

Restrictions

Use of these weapons will be restricted to mowed areas and Green fire danger rating conditions.

MK19 Grenade Launcher

The maximum range for blast fragments from the MK19 grenade launcher is 2.4 km (1.5 mi). It can fire 40 mm grenades, smoke grenades, and other grenades (Figure PD 15).

Restrictions

Only M385A1 inert rounds, with cartridge cases that detach from the projectile so that they land within 100 m (328 ft) of the firing point, will be used in Yellow fire danger rating conditions. Inert rounds that meet this specification may be fired when live herbaceous fuel moisture is 60 percent and higher. No other rounds will be fired from the MK19 grenade launcher until after the Kaluakauila, Kahanahaiki and Ohikilolo fuelbreaks and firebreaks are constructed and the expedited stabilization of three endangered plant species is completed (see Table PD 2). To minimize the areas where fires may be ignited by this weapon, the MK19 will not be fired east of the 580,900 m UTM line.

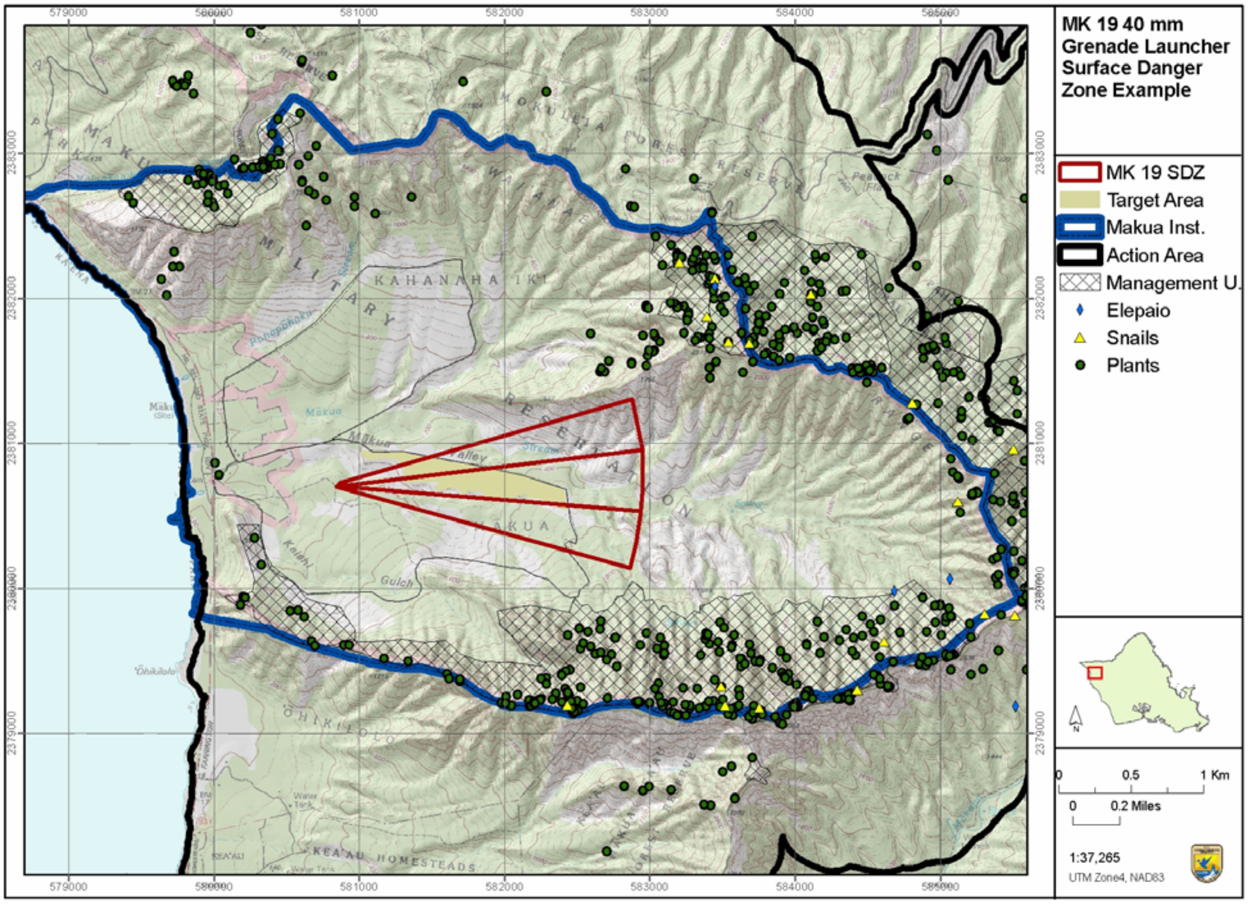


Figure PD 15. MK19 grenade launcher surface danger zone.

Simulators, Mines and Grenades

Explosive charges are used to simulate detonation of mines and incoming artillery projectiles, mortars, and bombs during training exercises. All use of these types of devices will be in accordance with Army Regulation 385-63, *Range Safety Manual*. Procedures for the safe use of many of these weapons, including explosives such as TNT or composition C4, require use to be limited to excavated demolition pits surrounded by a sand bag barrier. When Area F (which generally has a 30-m (98-ft) radius) is designated on the surface danger zone for the particular weapon, it will be cleared of flammable vegetation. To minimize the chance of a fire igniting outside the firebreak road, simulators, mines, and grenades will be oriented, when possible, in a way that directs hot gasses or blast fragments toward the interior of the south lobe of the firebreak road.

60 mm Mortars

Sixty mm mortars are used for indirect fire and support of troops. Mortar rounds are shot from a launch tube attached to a base plate, using 60 mm high explosives, 60 mm short-range training ammunition, or 60 mm inert ammunition. The 60 mm inert round has no explosion upon impact; the short-range training ammunition has a flash, bang, and smoke on impact, while the high explosive cartridge has a large explosion. The M720 and M888 high explosive cartridges have high fragmentation steel loaded with Composition B explosive that explodes on impact. The M720 cartridge is equipped with the M734 multi-option fuse, which can be set to function in the proximity, near surface burst, impact, or delay mode. The M766 short-range practice cartridge is designed for use with the M224 60 mm mortar system and provides realistic, cost effective training. The M766 is similar to the 60 mm high explosive cartridge in exterior configuration and operation. It reduces the cost of training and permits training in areas with limited range space. The M766 is equipped with the M779 practice fuse, which is a facsimile M734 multi-option fuse. Maximum range of the short-range training ammunition is 530 m (1,739 ft). The rounds are propelled by doughnut charges. The maximum range of the high explosive and inert mortars is 3,500 m (11,483 ft). The number of charges and firing angles will be limited so that the weapon's maximum range or "Distance X" on the developed surface danger zone is 760 m (2,493 ft) at Makua. The maximum distance the 60 mm round can travel at Makua will be limited to 760 m (2,493 ft) or less by enforcing strict limits on the charge used and the angle that the weapon is fired (Figure PD 16).

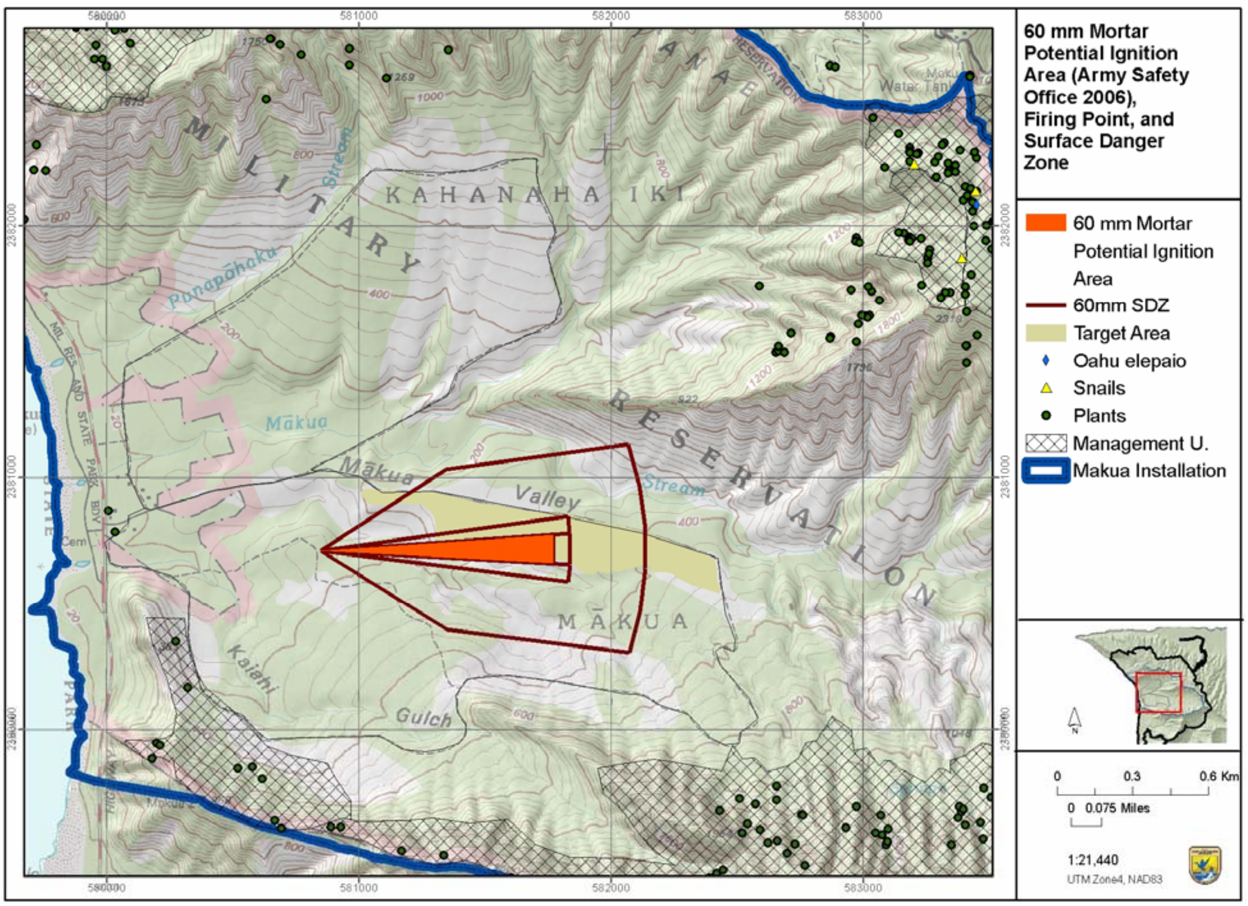


Figure PD 16. Potential ignition area and surface danger zone for 60 mm mortar.

81 mm Mortars

Similar to the 60 mm, this weapon consists of a launch tube mounted on a base plate. It is used for indirect fire support of troops. It fires 81 mm high explosive mortar and 81 mm target practice inert mortars. The 81 mm inert round has no explosion upon impact while the 81 mm high explosive has a large explosion. High explosive cartridges are designed for use against personnel, bunker and light materiel targets. The high fragmentation steel projectile is loaded with Composition B explosive. Maximum and sustained rates of fire are 15 to 30 rounds per minute. The rounds are propelled by doughnut charges. This 81 mm weapon has a maximum possible range of 5,900 m (19,357 ft). The number of charges and firing angles will be limited so that the weapon's maximum range or "Distance X" on the developed surface danger zone is 1,760 m (5,774 ft) or less at Makua. The maximum distance the 81 mm round can travel at Makua will be limited to 1,760 m (5,774 ft) or less by enforcing strict limits on the charge used and the angle that the weapon is fired (Figure PD 17).

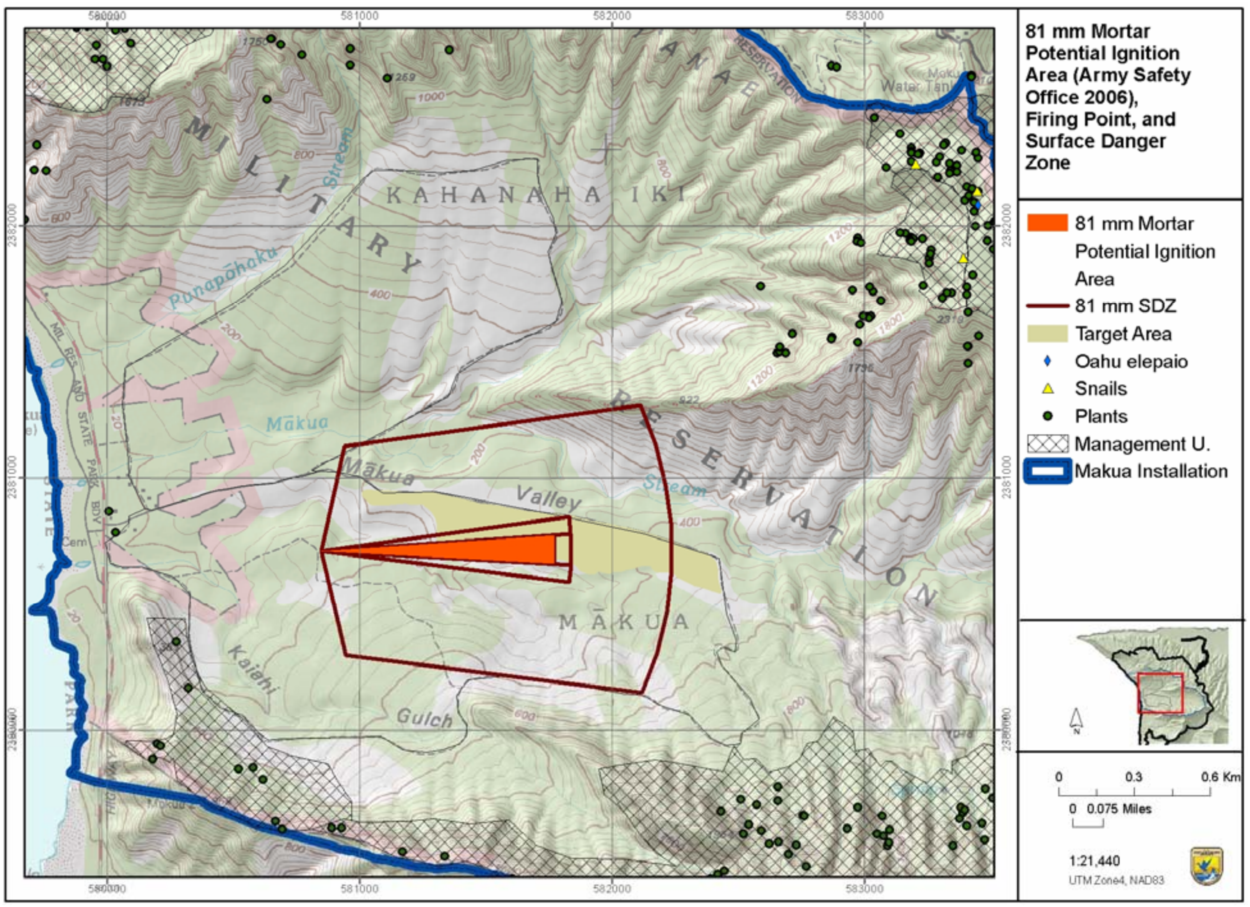


Figure PD 17. Potential ignition area and surface danger zone for 81 mm mortar.

120 mm Mortars

The 120 mm mortar consists of a tube mounted on a trailer or vehicle (Figure PD 18). It is used for indirect fire support of troops. It generally fires a fin-stabilized, 120 mm high explosive mortar from a smooth bore. It can also be fitted with a sleeve so that it can fire 81 mm projectiles. The M120 mortar system consists of the M298 cannon assembly, M190 bipod assembly, M9 baseplate, and M1100 trailer. The 120 mm high explosive has a large explosion. Only high explosive cartridges will be fired from the M120. The M933/934 high explosive cartridges are designed for use with the M120 and M121 120 mm mortar systems and are used against personnel, bunker and light materiel targets. The 1090 steel projectile is loaded with Composition B explosive. The M934 is equipped with the M734 multi-option fuse that can be set to function in the proximity, near surface burst, impact, or delay mode. The rounds are propelled by charge bags. This weapon has a maximum possible range of 7.2 km (4.5 mi). The number of charges and firing angles will be limited so that the weapon's maximum range or "Distance X" on the developed surface danger zone is less than 1.6 km (5,249 ft) at Makua. The maximum distance the 120 mm round can travel at Makua will be limited to 1.6 km (5,249 ft), enforcing strict limits on the charge used and the angle that the weapon is fired (Figure PD 19). The maximum and sustained rates of fire are 16 rounds/min for the first minute and 4 rounds/min thereafter.

Figure PD 18. The 120 mm mortar may be fired from Stryker or other vehicles or from the ground using a mortar plate (Photos: Global Security.org).

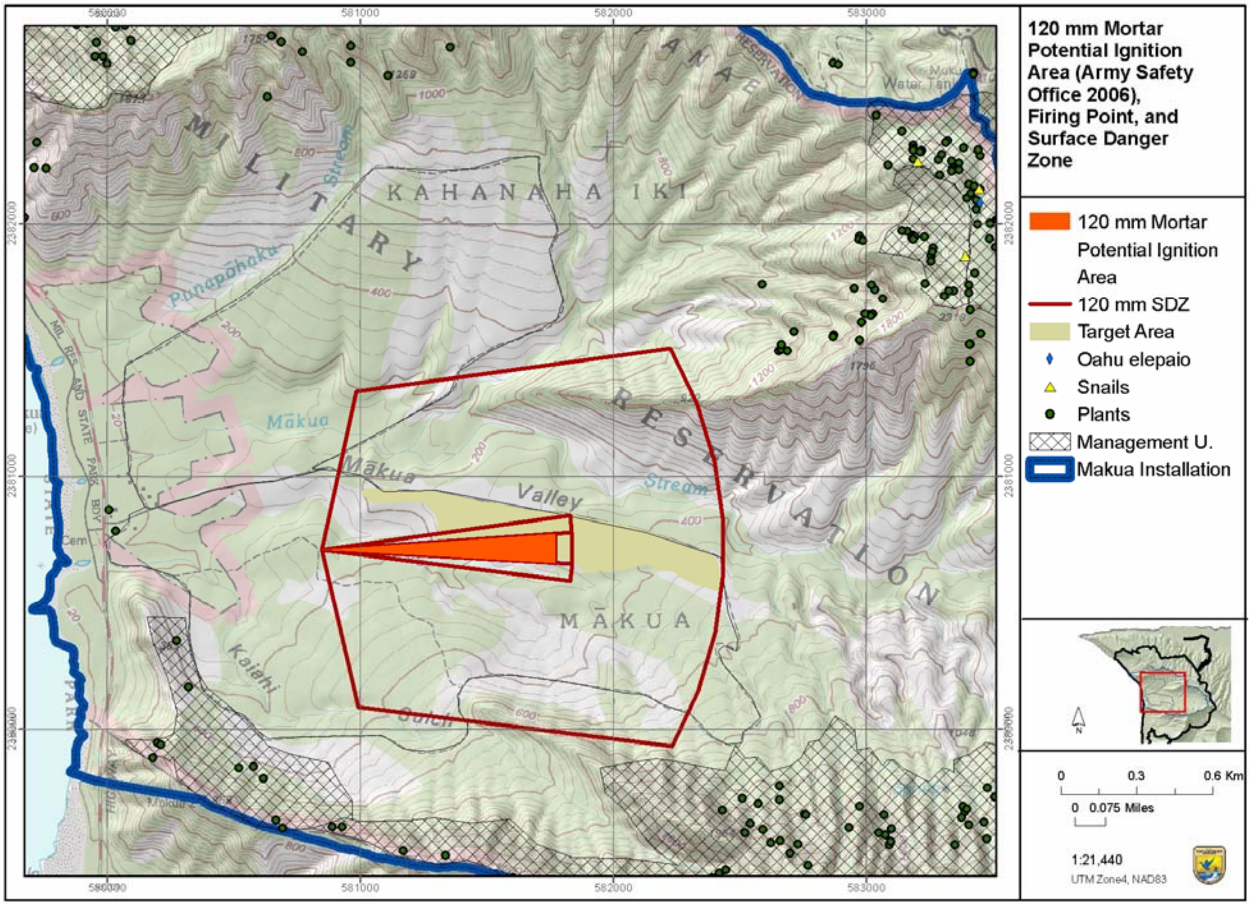


Figure PD 19**.** 120 mm mortar potential ignition area, firing point, and surface danger zone.

<u>Restrictions for all Mortar Training</u>

Mortars will only be fired from the designated spot in the mowed area (EJ 8085-8071) known as Coyote on the maps in this Project Description. Mortars will only be targeted at Objective Deer (EJ 8190-8070). Historically, the first round fired from a mortar would sometimes land outside the impact area because the force from this first shot is used to seat the mortar plate into its firing position. The number of charge bags used are closely controlled, counted out separately and inserted in the tube, and double checked prior to firing the weapon by at least four different personnel. At Makua, all mortar plates will be seated into place with a sledge hammer prior to firing the first round in order to better ensure accuracy of all mortar rounds fired.

No infrared, illumination or smoke cartridges will be used at Makua because of their increased fire risk.

105 mm Artillery

This weapon is a 1,814 kg (4,000 lb) cannon, generally towed by vehicles or airlifted into firing position, which is used for direct and indirect fire support of troops (Figure PD 20). The weapon has an average crew of seven Soldiers. It is capable of firing a wide range of standard NATO ammunition. At Makua, it will fire high explosive and inert rounds. The 105 mm inert round has no explosion upon impact, while the 105 mm high explosive has a large explosion. This 105 mm weapon has a range of 19.2 km (11.9 mi) when rocket assistance and eight charge bags are used. The number of charge bags and firing angles will be limited so that the weapon's maximum range or "Distance X" on the developed surface danger zone is 2,400 m (1.5 mi) or less at Makua. This maximum range will be limited by enforcing strict limits on the charge used and the angle that the weapon is fired (Figure PD 21). The amount of powder in each charge bag and the number of charge bags used is closely controlled. Charges are counted out separately and inserted in the tube, and double checked prior to firing the weapon by at least four different personnel. Artillery will only be fired from the designated spot in the irrigated green and mowed grass area in the north lobe of the firebreak road. Artillery will only be targeted at Objective Deer.

Figure PD 20. Photograph of 105 mm artillery.

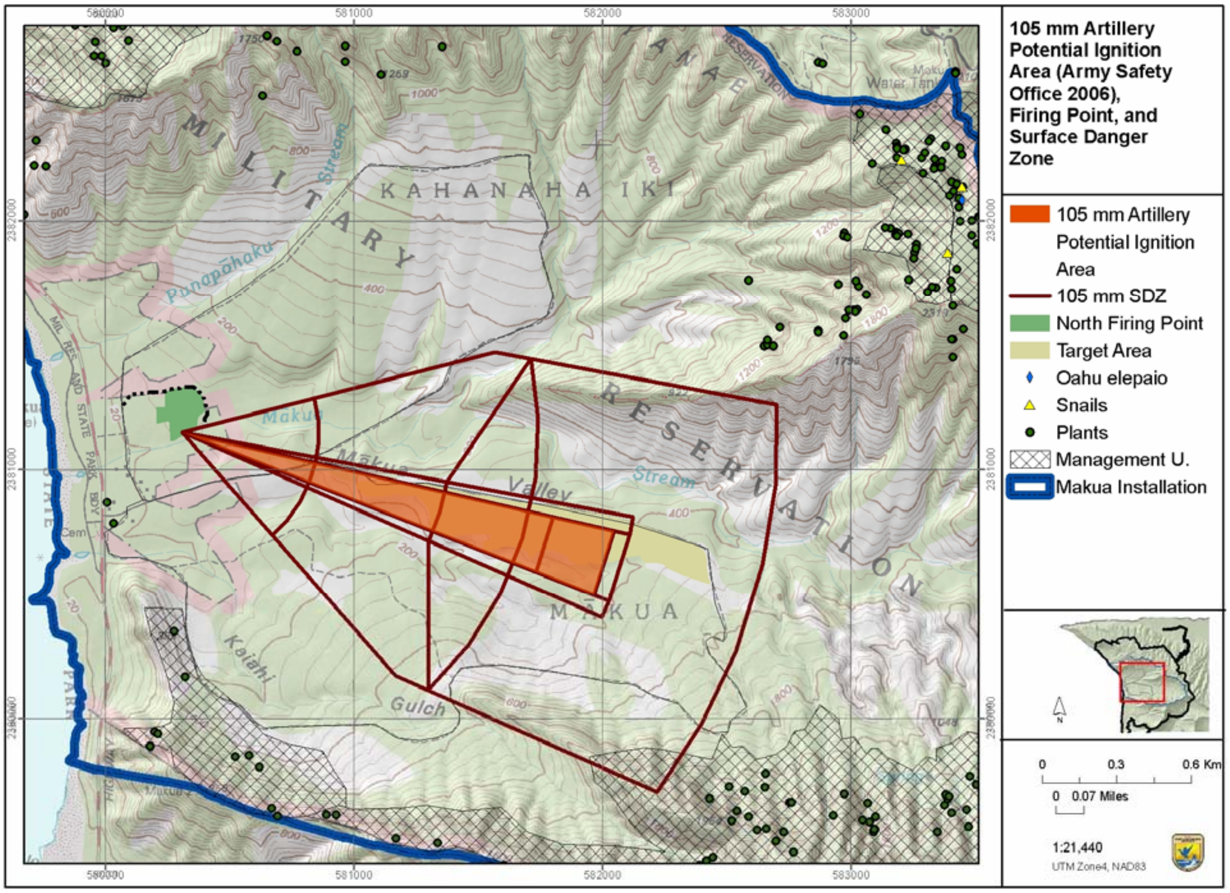


Figure PD 21. Surface danger zone and potential ignition area for 105 mm artillery.

155 mm Artillery

This weapon is a 7.1 kg (15,758 lb) cannon, generally towed by vehicles or airlifted into firing position, and used for direct and indirect fire support of troops (Figure PD 22). It is capable of firing a wide range of standard NATO ammunition. The 155 mm howitzer barrel can be fitted with a sleeve so that it fires 105 mm ammunition. At Makua, it will fire high explosive and inert rounds. The 155 mm inert round has no explosion upon impact, while the 155 mm high explosive has a large explosion with fragments and blast effects confined to the surface danger zone. The maximum effective range of this weapon is 22.4 km (13.9 mi) with conventional ammunition and 30 km (18.6 mi) using a rocket-assisted projectile. The maximum and sustained rates of fire are four and two rounds per minute, respectively. The howitzer is transported and operated by a crew of nine. The number of charge bags and firing angles will be limited so that the weapon's maximum range or "Distance X" on the developed surface danger zone is 2,600 m (1.6 mi) or less at Makua (Figure PD 23). The maximum range for this weapon, given three bags of powder is 6,100 m (12.4 mi). To minimize the distance the 155 mm round can travel, the Army will enforce strict left and right limits, limit the angle that the weapon is fired, enforce use of the safety card (specifies the limitations of using at the range), and complete the firing solution (adjusting the direction of fire of the weapon) by two different methods, by hand and by computer, to ensure the two match up before firing. The amount of powder in each charge bag and the number of charge bags used is closely controlled. On Oahu, the charge bags are limited to no more than two to limit the distance the ammunition can travel. Upon preparation for firing, the projectile and propellant are loaded into the howitzer in two separate operations. Separate loading ammunition propellants are issued as a separate unit of issue in sealed canisters to protect the propellant. The amount of propellant to be fired with artillery ammunition varies with the number of propellant increments. The charge selected is based on the range to the target and the tactical situation.

Restrictions

Illumination and white phosphorus (smoke) rounds will not be fired at Makua. Charges are counted out separately and inserted in the tube, and double-checked prior to firing the weapon by at least four different personnel. Artillery will only be fired from the designated spot in the irrigated green and mowed grass area in the north lobe of the firebreak road. Artillery will only be targeted at Objective Deer.


Figure PD 22. 155 mm artillery. (Photos: Department of Defense: www.defenselink.mil)

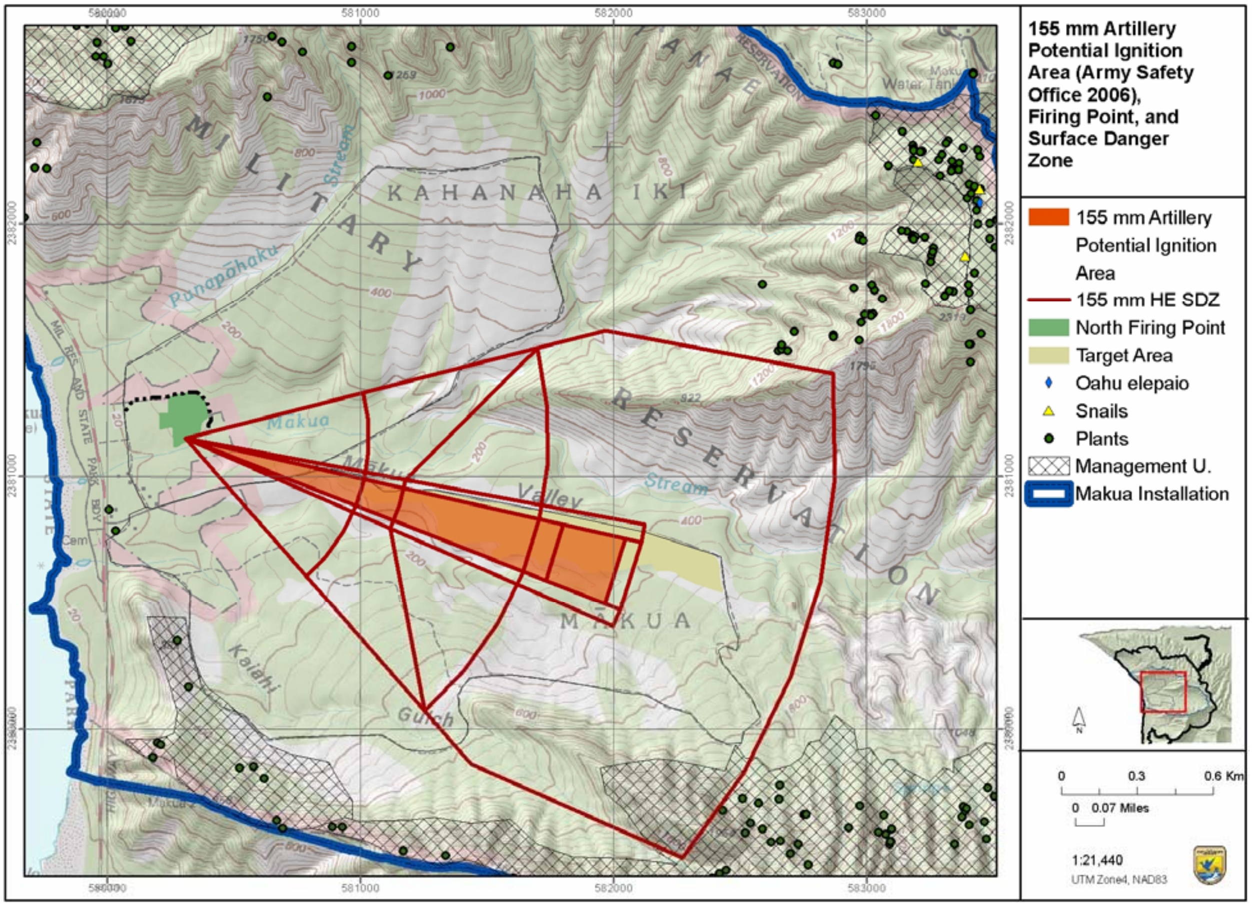


Figure PD 23. Potential ignition area, firing point, and surface danger zone for 155 mm artillery.

AT-4 Anti-Armor Weapon

The AT-4 is a lightweight, shoulder-fired, anti-armor weapon. Each AT-4 is pre-packaged and sealed with only one round of ammunition. It fires a rocket-type cartridge consisting of a fin-stabilizing assembly with a tracer element and a warhead consisting of an 84 mm, shaped, high-explosive warhead. Although the M136 AT-4 can be employed in limited visibility, the firer must be able to see and identify the target and estimate the range to it. The maximum range for the rocket is 2.1 km (1.3 mi). The AT-4 will be fired only from within the designated firing point in the north lobe of the firebreak road, a minimum of 50 m (164 ft) from the outer edge of the 7-ac (2.8-ha) mowed firing point with a minimum clearance of 95 m (311 ft) from any flammable vegetation. The designated firing point in the north lobe of the firebreak road will either be kept bare of vegetation or it will be mowed and irrigated, so that live herbaceous fuel moisture of the grass in all areas remains above 200 percent. The firing point will be bounded directly along its north and east edges by a new improved firebreak road, 469 m (1,539 ft) long and following the route of an area historically used as an access road, maintained with bare ground to a width not less than 6 m (19.7 ft) (Figure PD 24). The AT-4 will be targeted at Objective Deer (EJ 8190-8070). The AT-4 will not be fired until after the Kaluakauila, Kahanahaiki and Ohikilolo fuelbreaks and firebreaks are constructed and the expedited stabilization of three endangered plant species is completed (see Table PD 2).

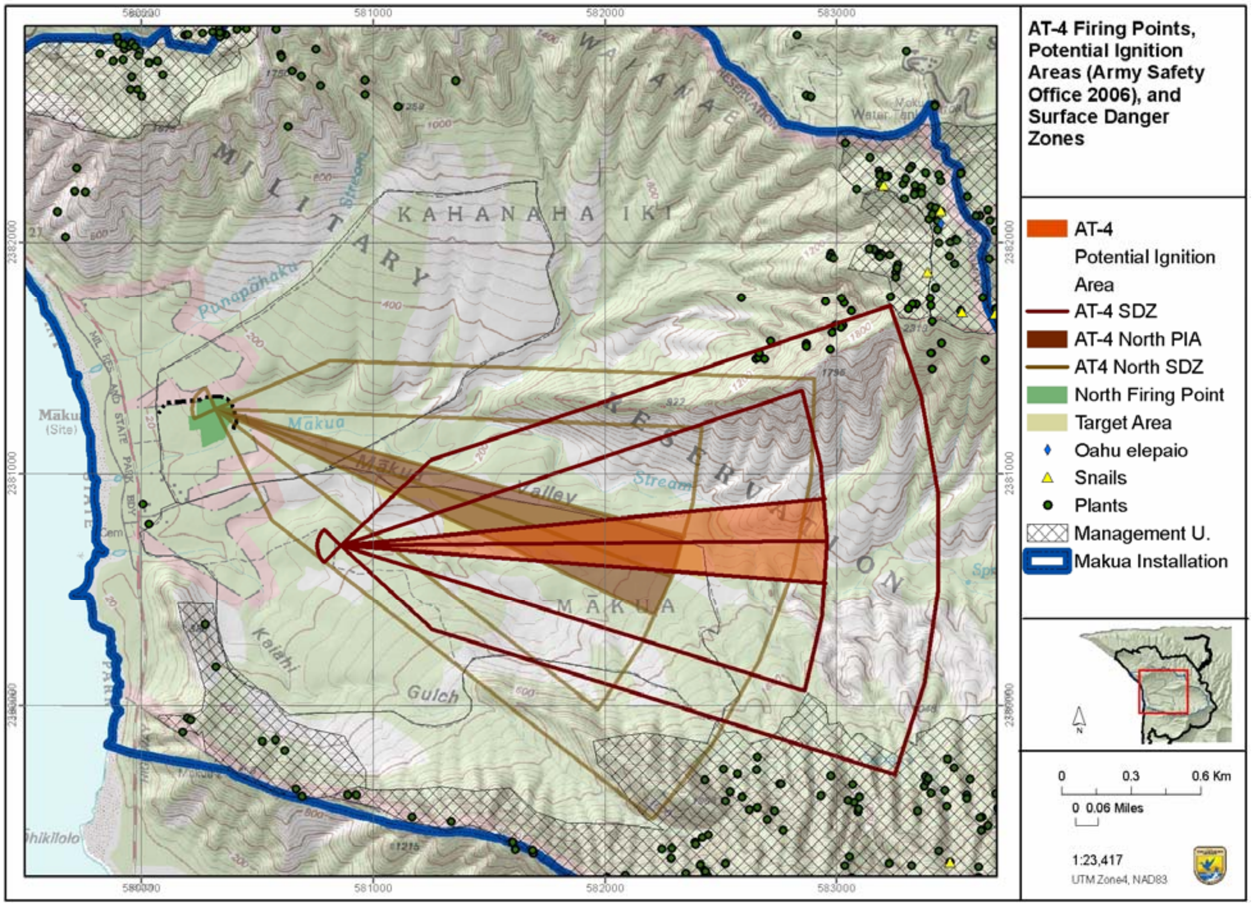


Figure PD 24. AT-4 surface danger zone, designated irrigated firing point, and maintained firebreak locations.

SMAW

The Launcher Assault Rocket 83 mm (SMAW) is a hand held fiberglass launch tube with a mounted sight and a maximum range of 2.0 km (1.2 mi). There is a 30-m (98-ft) back-blast area behind the firing point where hot flying debris could land, so this weapon will only be fired from the designated firing point in the north lobe of the firebreak road. The weapon will only be fired at a target in Objective Deer. This weapon is used at Makua by the Marine Corps. No surface danger zone is available for the SMAW, but its range and effects are similar to the AT-4. The SMAW will not be fired until after the Kaluakauila, Kahanahaiki and Ohikilolo fuelbreaks and firebreaks are constructed and the expedited stabilization of three endangered plant species is completed (see Table PD 2).

Tracers

Tracer ammunition is used to illuminate a shooter's line of fire at night or during the day, depending on the type of tracer used. A bright-burning pyrotechnic compound is added to a specially formed cup in the rear of the jacket of a given ammunition type. When the powder is ignited, it in turn ignites the tracing compound. This leaves a bright luminescent trail behind the bullet in flight, allowing the shooter to see the path of the projectile. Tracers are used primarily in machine gun and rifle applications, where every fourth or fifth round is a tracer. Only 5.56 mm, 7.62 mm, and .50 caliber M1 tracers will be fired from ground and Stryker-based locations and only 5.56 mm and 7.62 mm tracers will be fired from helicopters. Tracer burnout distances are as follows: 5.56 mm is 900 m (0.6 mi) (HQDA FM 23-14), 7.62 mm is 900 to 1,000 m (0.6 to 0.62 mi), and .50-caliber M1 is 1,800 m (1.1 mi) (HQDA FM 23-65) (Figure PD 25).

Restrictions

Use of all other tracers, including M17 tracers, is prohibited at Makua. Tracers will be fired by ground troops and from Strykers. Small arms tracers will be fired from various locations within the south lobe of the firebreak road, at various targets within the south lobe of the firebreak road. All firing points, including firing points for tracers fired from helicopters, will be within the south lobe of the firebreak road, east of UTM 581,400. M1 tracers will not be fired from any point farther east than the UTM 581,400 line within Objective Deer. Tracer ammunition will be used in accordance with the weapons restrictions specified in Table PD 2. Tracers will not be fired until after the Kaluakauila, Kahanahaiki and Ohikilolo fuelbreaks and firebreaks are constructed and expedited stabilization of three endangered plant species is completed. Prior to completion of expedited stabilization of 12 species, tracer ammunition will be used only when live herbaceous fuel moisture, calculated at the Makua Range WIMS weather station, is 120 percent or higher and when fire danger is low (Green). After expedited stabilization of 12 species is completed, tracers will only be fired when live herbaceous fuel moisture is 100 percent and higher when fire danger is low (Green). Fire suppression forces will be staffed pursuant to fire suppression staffing requirements described in Section 3 of the Project Description.

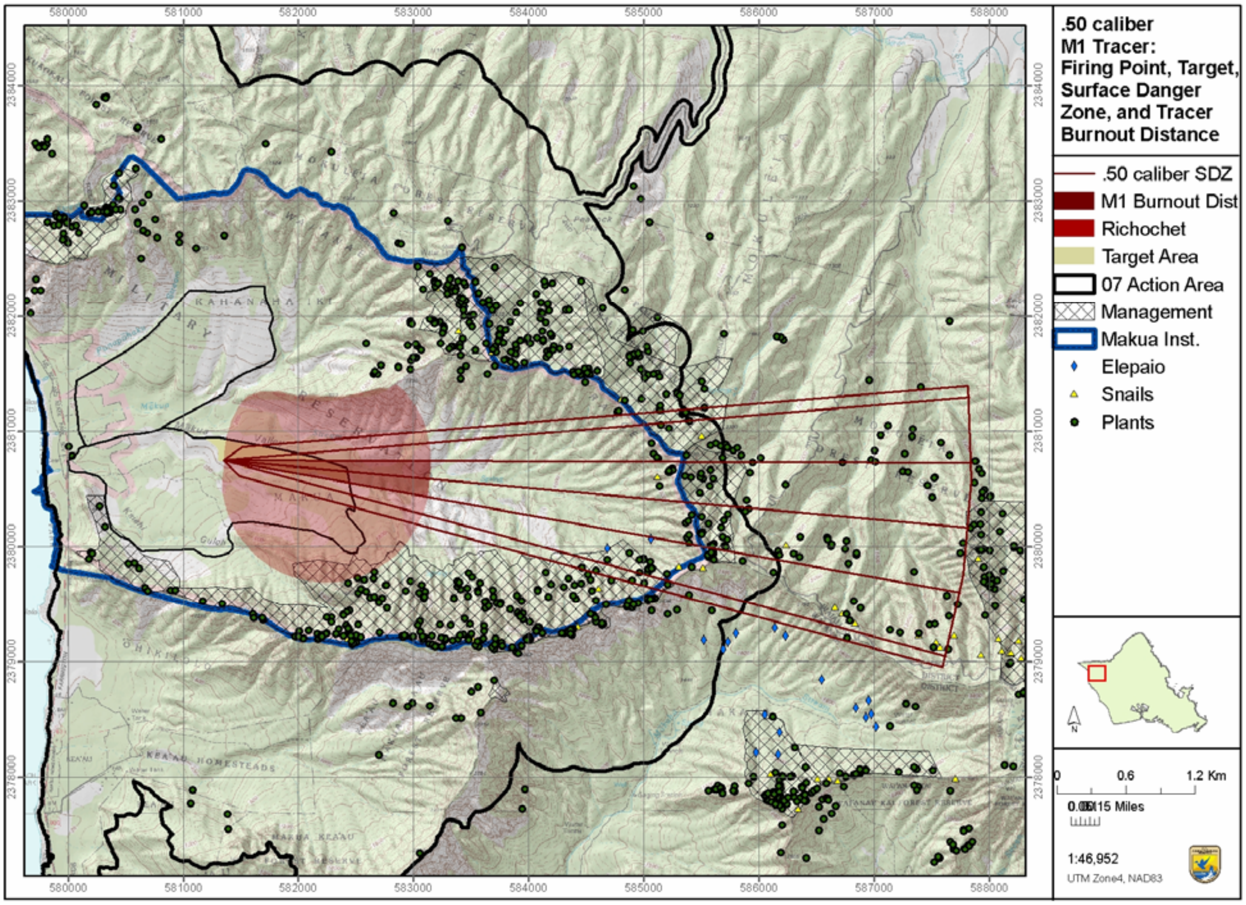


Figure PD 25. M1 tracer static firing point, target, surface danger zone and tracer burnout distance, and possible tracer ricochet dispersion area.

2.75-caliber Rocket

The 2.75-caliber (70 mm) Hydra-70 rocket system proposed for use at Makua consists of a seven-tube M260 launch tube, the MK66 MOD 4 rocket motor, and the blue spear WTU1B inert, ten pound steel training warhead (Figure PD 26). No other warhead or motor will be used at Makua. For use at Makua, the launch tube will be attached to an OH-58 Kiowa or similar helicopter. Only pilots with current qualifications in the use of 2.75-caliber rockets will fire these helicopter-mounted weapons in support of ground troops during CALFEX exercises. Makua will not be used for training, recertification, or qualification flights for 2.75-caliber rocket use. Rockets will be used by skilled, qualified pilots in order to provide realistic experience for personnel training on the ground. No more than 56 rockets will be fired during each CALFEX iteration. The rocket will be fired from approximately 1.0 km (0.6 mi) range at a target, which will be located in Objective Deer or Elk. The rocket will be fired from a Kiowa or similar helicopter flying below 134 m (440 ft) altitude, at a minimum of 60 knots airspeed, at a nose down dive, with a nose-down angle of at least 10 degrees. The rocket will never be fired from a helicopter that is not at a nose-down position of at least 10 degrees.

Figure PD 26. Example of 2.75-caliber rocket being fired from a helicopter and 2.75-caliber (70 mm) rocket pod mounted on the side of a helicopter. Unlike the rocket being fired in the photograph, rockets fired at Makua will only be fired from helicopters with nose-down angles of 10 degrees or more.

The Army currently uses a surface danger zone developed for a rocket fired from a level helicopter over flat terrain, in which the rocket has a maximum range of 3.0 km (1.9 mi). Topographic correction to the surface danger zone was completed by the Center for Environmental Management of Military Lands (Beavers 2006). Topographic correction is shown for a surface danger zone created for a rocket fired straight ahead (not nose down) at an altitude of 134 m (440 ft) (see Figure PD 26). At this time, surface danger zones when firing this weapon at a down angle have not been formally adopted by the Army. The maximum range (Distance X) of rockets fired from nose-down helicopters would be shorter than the range shown in Figure PD 27. The chance of a 2.75 rocket landing outside the Makua installation boundary is less than one in a million. An estimated 5,040 rounds will be fired in the next 30 years. Therefore, there is a 1:200 (1,000,000 divided by 5,040) chance of a round escaping from the installation boundary over the next 30 years.

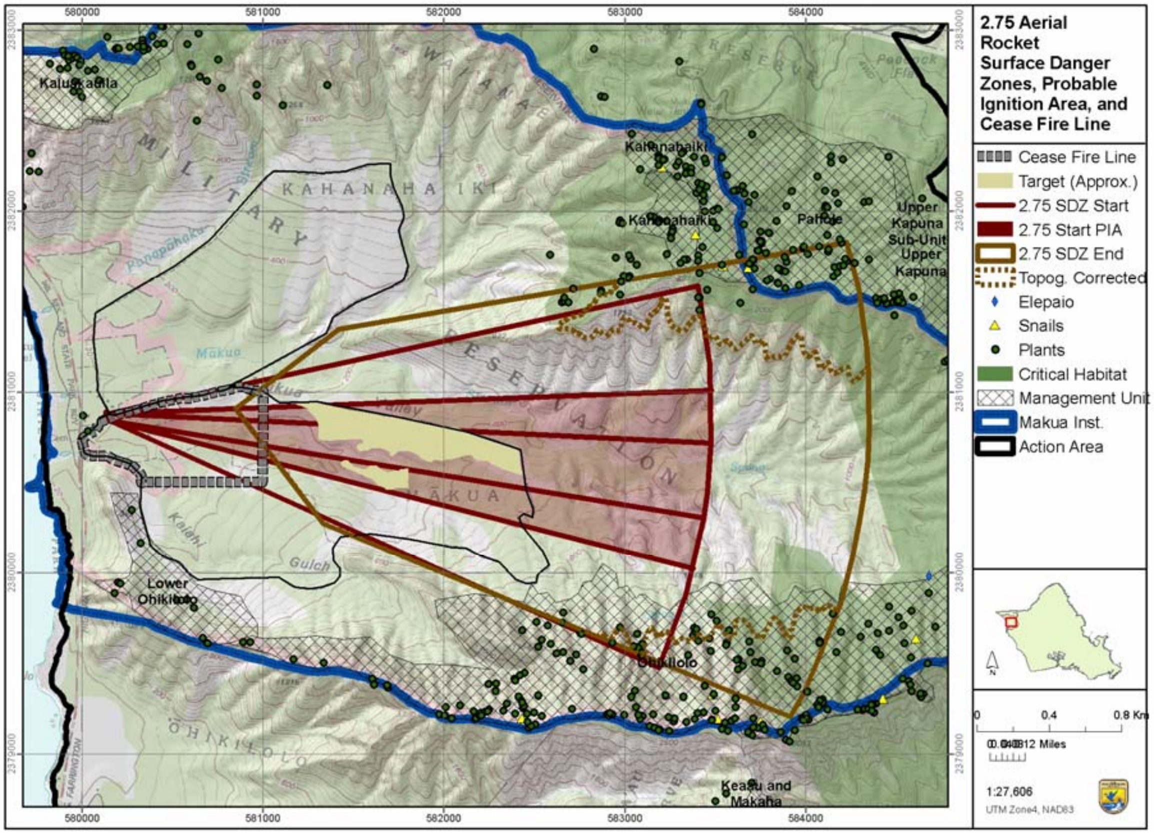


Figure PD 27. Surface danger zones (1: 1 million chance of escapement), an example of an associated probable ignition area, and the perimeter of the live-fire area cease fire lines (581,000 UTM line and roads) to be used for 2.75-caliber aerial gunnery rocket firing.

Restrictions

These rockets will not be fired until after the Kaluakauila, Kahanahaiki and Ohikilolo fuelbreaks and firebreaks are constructed and the expedited stabilization of 12 endangered plant species is completed (see Table PD 2). To ensure that hot residuals associated with the launch of the rocket do not fall outside the south lobe of the firebreak road or into Lower Ohikilolo Management Unit, rockets will not be fired south of 21º 31' 30'' North Latitude (the UTM NAD83 2380500 m line). To prevent the topographically corrected surface danger zone from overlapping with the management units on C-Ridge, rockets will not be fired above 122 m (400 ft) above ground level (AGL) and no further east than 158 º 13' 10''West Longitude (the UTM NAD83 581,000 m line). These cease fire lines will be visually marked on the ground with a minimum of 10 panels so that pilots can easily identify limits to live fire from the air. Ground markings will be visible to both the pilots and to an observer situated on the tower at the Makua Range office. A passing score for a 2.75 qualification exercise is one out of three, or three out of seven hits within a 100 by 100 m (328 by 328 ft) target box around a tank-sized object (Master Gunner S. Lodge, U.S. Army, pers. comm. 2006). The entire target box will lie inside the south lobe of the firebreak road. Although many rounds are expected to land outside the firebreak road, most of them will be within 800 m (2,624 ft) of the target. The rocket is propelled by burning propellant in a tube-shaped rocket motor. The motor burns out at approximately 450 m (1,476 ft), but the tube remains hot enough that it can ignite vegetation on impact 3.0 km (1.9 mi) down-range (S. Lodge, US Army, pers. comm. 2006).

Errors and malfunctions that have the potential to result in a rocket being fired outside the 3.0 km (1.9 mi) surface danger zone, can be minimized so that this weapon can be used safely at Makua. The maximum range for this weapon, if it were fired at a 45 degree positive angle, is 12.0 km (7.5 mi). To better ensure that rockets are only fired when the helicopter is in a dive, a second certified 2.75-caliber rocket pilot will be in the copilot seat and will arm the weapon only when the helicopter is at least 10 degrees nose down and below 134 m (440 ft altitude) (122 m (400 ft AGL)). Wind gusts affect rocket firing accuracy by affecting the helicopter's movement and by affecting the rocket's flight. Rockets tend to fly into the wind. Operations conducted in conjunction with aerial rocket firing will be suspended (per Army Regulation 385-63, *Range Safety Manual*) for one hour if wind gust is more than 30 knots (35 mph) as indicated by the maximum windspeed measured at the Makua Range weather station during the previous hour (available at http://www.wrcc.dri.edu/cgi-bin/rawMAIN.pl?hiHMAR). Skilled pilots will take wind into account when positioning their helicopter for firing to ensure that the landing skids running the length of the helicopter will be at a 10 degree front-down angle or greater whenever a rocket is fired at Makua.

Malfunctions of equipment resulting in a hang fire or a substantially misdirected rocket are rare. A hang fire, where the rocket is fired but does not leave the launch tube mounted to the helicopter, can result in a 10 degree "yaw" of the helicopter to the left or right. Our local 125th Battalion master gunners estimate that a hang fire occurs once for every 300,000 rockets fired. It is possible, but unlikely, for the pilot to be firing the trigger in ripple mode (which would enable deployment of 14 rockets in under six seconds), and, in a hang fire situation, a rocket could be fired 10 degrees off of the intended target. During these types of training exercises, pilots are likely to only fire two to four rockets during each pass at the target area so they are unlikely to employ ripple mode. Given a hang fire situation, the pilot may chose to jettison the launch tube assembly from the side of the helicopter. If the propellant in the rocket motor has been cracked, which could occur if it has been mishandled or dropped, the resulting uneven motor burn could potentially result in the rocket deploying at a 45 degree angle, regardless of the helicopter's nose-down position. However, the rocket's range would be reduced to 6.0 km (3.7 mi) (Yuma Proving Ground rocket specialist), and if the rocket contacted the helicopter's rotor blade, its range would be reduced even further. Recent changes in regulations regarding this weapon prohibit the use of any motor that has been dropped any distance. There is also the possibility of a malfunction of the rocket's side fins which could result in the rocket veering off course. However, the malfunction would also create a wobble in the rocket's flight and therefore the range of the malfunctioning rocket would be substantially reduced. A fin malfunction has not happened to any of the 300,000 2.75-caliber unguided rockets the 125th Battalion master gunner or the Yuma Proving Ground rocket specialist has observed. The 2.75-caliber rocket will be fired only when live herbaceous fuel moisture, calculated at the Makua Range WIMS weather station, is 100 percent or higher and when fire danger is low (Green). Fire suppression forces will be staffed pursuant to fire suppression staffing requirements.

Javelin Missile

The Javelin is a portable anti-tank weapon. It is shoulder-fired and can also be installed on tracked, wheeled or amphibious vehicles (Figure PD 28). The Javelin system consists of the Command Launch Unit and the round. The round consists of the Javelin missile and the ATK (Alliant Techsystems) Launch Tube Assembly. Javelin is a fire-and-forget missile with lock-on before launch and automatic self-guidance. The propulsion system is a two stage solid propellant design which provides a minimum smoke soft launch. At 1,000 m (0.6 mi), the flight motor is fully exhausted. Therefore, the surface danger zone, created for flat terrain, overestimates the maximum range of the weapon, given the terrain in the Makua valley. The tandem warhead is fitted with two shaped charges: a precursor warhead to initiate explosive reactive armor and a main warhead to penetrate base armor. At Makua the Javelin will be locked onto and fired at a heat source.

Restrictions

Tracers will not be fired until after the Kaluakauila, Kahanahaiki and Ohikilolo fuelbreaks and firebreaks are constructed and the expedited stabilization of 12 endangered plant species is completed (see Table PD 2). The weapon will be fired no closer than 25 m (82 ft) from the firebreak road to ensure that back blast resulting from activation of the flight motor pressure relief system does not ignite a fire outside the firebreak road. The blast will be contained by bunkers built around the targets. The vegetation within 10 m (32 ft) of the bunker will be maintained at stubble height. The maximum range of the missile is 4.0 km (2.5 mi) (Figure PD 29). The Javelin will be used only when live herbaceous fuel moisture, calculated at the Makua Range WIMS weather station is 100 percent or higher, and when fire danger is low (Green). Fire suppression forces will be staffed pursuant to fire suppression staffing requirements.

Figure PD 28. Javelin missile photographs from www.army-technology.com.

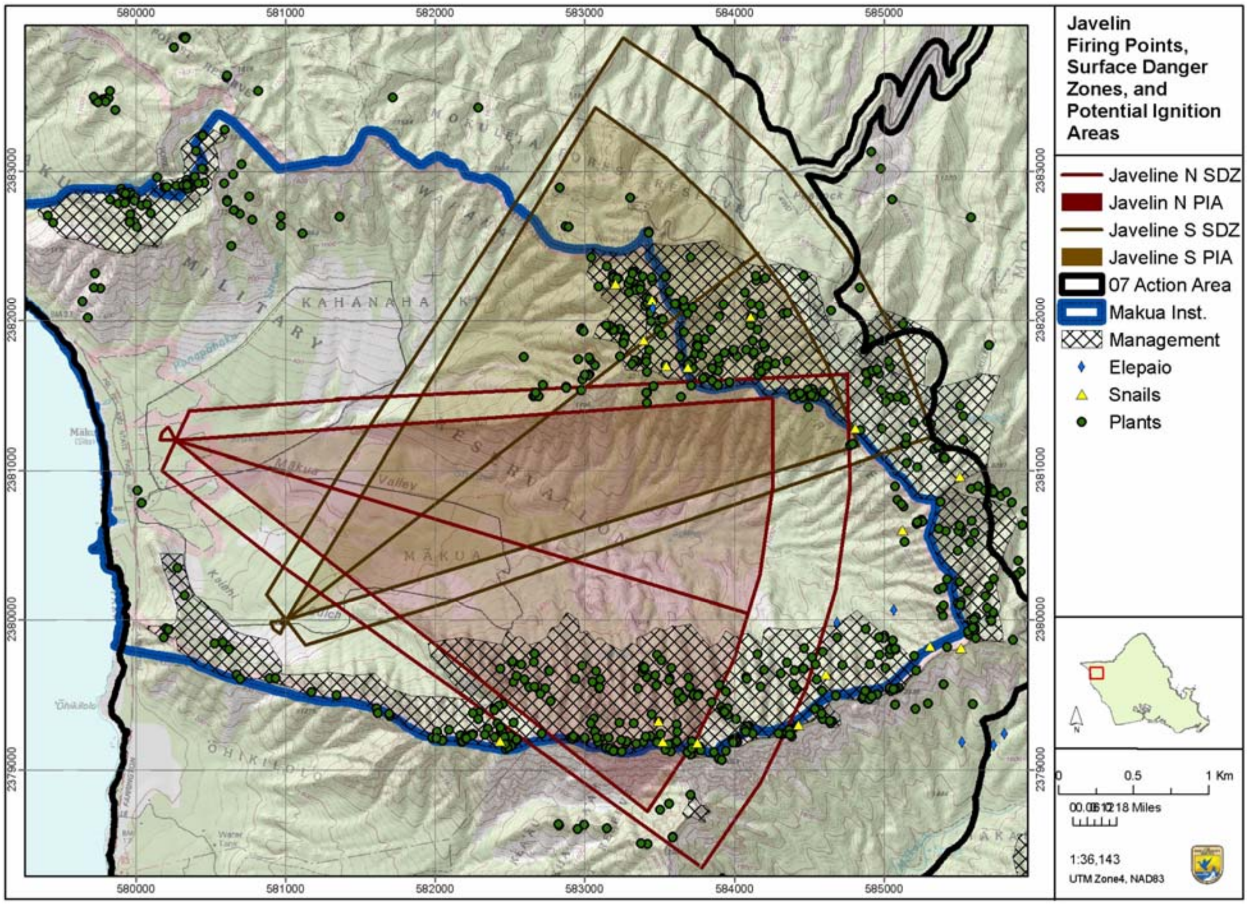


Figure PD 29. Javelin 1:1 million surface danger zones and potential ignition areas for northern and southern firing points.

TOW Missile

This is a line-of-sight, tube-launched, optically-tracked, wire-guided (TOW) missile system. This system is composed of a reusable launcher, a missile guidance set and sight system (Figure PD 30). The system can be tripod mounted; however, because it is heavy, it is generally employed from a high mobility multi-purpose wheeled vehicle. TOW missiles will not be fired from helicopters at Makua. TOW missiles are used primarily in anti-tank warfare to engage and destroy enemy armored vehicles and other targets such as field fortifications. The maximum range of the missile, fired from a ground position, is 5.0 km (3.1 mi) (Figure PD 31). Only inert TOWs with concrete warheads will be shot at Makua. TOW missile blast effect simulators may also be used. The missile's movement is fueled by burning propellant, which can remain ignited for a distance up to the maximum range of 5.0 km (3.1 mi). The TOW is optically-tracked and wire-guided by the person firing the weapon. If the wire snags or detaches from the TOW, the warhead is no longer controllable, often quickly plummeting into the ground. However, in other instances, it flies erratically for some distance and there is the potential, although extremely limited, for the malfunctioning weapon to travel up to 5 km (3.1 mi). Malfunction rate information for the TOW was not readily available for use in this consultation. Data published by Redstone Arsenal for airborne TOW missiles fired in combat in 1972 and 1973 indicates that 82 percent of TOW missiles hit their targets, 18 percent missed their target, including seven percent which missed their target due to a malfunction (http://www.redstone.army.mil/history/tow/tow_chronology.htm.).

Restrictions

TOWs will only be used after full stabilization of all Makua Implementation Plan species has occurred, including control of major threats. TOW missiles will not be fired until after the Kaluakauila, Kahanahaiki and Ohikilolo fuelbreaks and firebreaks are constructed (see Table PD 2). The TOW use will be limited to periods when live herbaceous fuel moisture is 100 percent or greater, and will only be fired when fire danger is low (Green) and when grass and forest fuels are less flammable. If an average of approximately 40 TOW missiles are fired each year for 30 years, then approximately 1,200 TOWs will be fired over the life of the project. At a malfunction rate of seven percent, 84 TOW malfunctions would occur over the life of the project. If a TOW malfunction results in a wildland fire outside of the impact area, the TOW will not be used at Makua again until all shrub and forest vegetation within the burned area is restored to its pre-fire species composition or better, and all Makua Implementation Plan species are at full stabilization.

Figure PD 30. Photograph of a TOW missile launch (The Warfighter's Encyclopedia http://wrc.navair-rdte.navy.mil/warfighter_enc/weapons/landlnch/m220tow.htm)

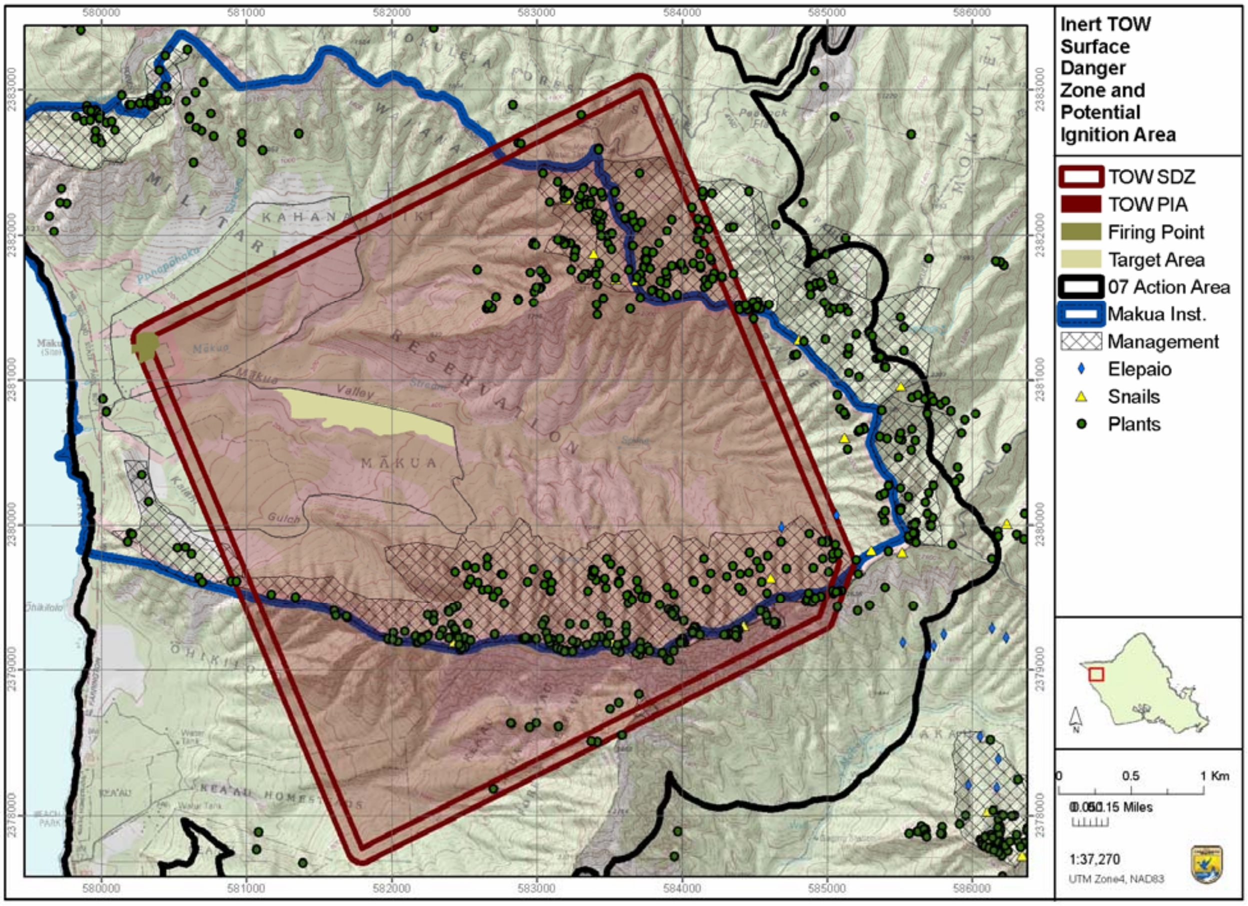


Figure PD 31. Surface danger zone and potential ignition area for inert TOW with concrete warhead, fired from within north lobe of firebreak road, targeted at Objective Deer.

9. Guinea Grass Fuel Model and Anticipated Fire Behavior Details

The CONTAIN module of the fire behavior model BehavePlus is the standard tool used by the National Wildfire Coordinating Group agencies for determining the number and type of fire suppression resources necessary to suppress fires under particular fuel moisture and weather conditions. It is used for both the development of prescribed fire contingency resource requirements and it is used for wildland fire suppression planning. BehavePlus compares the expected perimeter growth per unit time of a fire with the speed at which suppression forces are working to put out designated lengths of the perimeter during that time. A fire is "contained" when the suppression resources put out the perimeter of the fire. A fire "escapes" when the fire grows so fast, that the fire suppression resources are not able to contain the perimeter. The guinea grass (*Panicum maximum*), fuel model is a custom model which has received attention from the Center for Environmental Management of Military Lands (Beavers 2001), the US Forest Service (Wright et al 2002 and Scott and Burgan 2005), and the Service (D. Greenlee, unpublished 2006).

Fire behavior predictions for fires burning outside the firebreak road at Makua were based on a custom fuel model for local ungrazed stands of guinea grass originally developed by Beavers (2001), further described by Scott and Burgan (2005) and Wright et al (2002), and refined by Greenlee (unpublished 2006). Guinea grass fuel dominates the area between the firebreak road and the native vegetation surrounding Makua Valley (see Figure PD 2). Guinea grass is native to Africa and was cultivated and probably naturalized in Hawaii prior to 1871 as perennial forage for cattle (Wagner et al. 1999). Throughout its range, the grass reaches heights of 70 to 300 cm (2.3 to 9.8 feet). At Makua, the grass outside the firebreak road has an average height of 1.8 m (6 ft). One-third to 0.6 m (1 to 2 ft) of dead grass leaves form a thick thatch near ground level. Fuel loading is described in Beavers (2001). Of the 40 new fuel models described in Scott and Burgan (2005), guinea grass is heavier than all except for the four slash fuel models and four other heavy fuel models (SH7 Chaparral, SH9 Florida Scrub, TU5 and TL9 heavy forest understory or litter). Guinea grass fuel load estimates range from 8.8 to 11 tons per acre with fuel bed depth estimates between 0.5 m (1.8 ft) and 1.5 m (5 ft) (Beavers 2001, Wright et al 2002, and Scott and Burgan 2005). Kauffman (U.S. Forest Service) has extensive experience burning guinea grass pastures in Mexico and South America (Kauffman et al 1998, Guild et al 1998).

Fire rate of spread in guinea grass appears to be a factor of the greenness, or live herbaceous fuel moisture, of the grass. Although the layer of dead grass in the understory can support fire spread year-round (P. Costales, State Division of Forestry and Wildlife, pers. comm. 2006), fire behavior appears to be substantially reduced during periods when the standing grass contains a substantial component of green leaves with high moisture contents. Much of the heat of any fire burning through a stand of green grass is absorbed by the water in the grass, slowing the rate of spread of the fire. Guinea grass growth and grass greenness appears to be closely related to soil moisture. Consequently, during wet months, a high proportion of the standing grass leaves are green and the fuel moisture in those green leaves is high. During dry summer months, only a few of the leaves in the grass stand are green and the rest of the leaves are either standing dead or they are alive, but with very low fuel moisture contents. In the summer, when the majority of the stand is brown, this plant appears to produce a few fresh, green leaves, following substantial rainfall events. The WIMS uses the National Fire Danger Rating System algorithm for calculating live herbaceous fuel moisture based on precipitation.

Beavers et al (1999) GRASS2 fuel model appears to most accurately predict rate of spread of guinea grass head fires burning during the summer of 2006, when live herbaceous fuel moistures were lower than 99 percent, when the original fuel bed depth of 0.6 m (1.9 ft) is adjusted to 1.3 m (4.1 ft) (the fuel bed depth suggested by Wright et al 2002 and Scott and Burgan 2005). The complete halt in fire rate of spread predicted by the dynamic fuel models in Scott and Burgan 2005 for live herbaceous fuel moistures greater than 120 percent, predicted to occur in the Scott and Burgan (2005) model, due to a complete transfer of dead fuel to the live herbaceous fuel category does not occur in guinea grass stands due to a persistent layer of thatch in the understory. On a prescribed burn at Schofield Barracks on September 29, 2006 (live herbaceous fuel moisture 150 percent) and at Makua on December 8, 2006 (live herbaceous fuel moisture 163 percent) green grass adjacent to herbicide-treated grass was found with the thatch layer underburned, with the green grasses laying over unconsumed. In both instances, a hot head fire hit the green grass and fingers of the green grass burned 10 to 50 m (32.8 to 164 ft). Rate of spread has not been accurately measured on fires burning in green grass in part because when the headfire hits the green grass, the smoke turns to heavy steam due to the moisture content of the grass, obscuring the fire. Preliminary fuel model parameters, which the Army and the Service agree are likely to overpredict fire rate of spread in guinea grass with live herbaceous fuel moistures greater than 120 percent, will be used until the fuel model can be updated to the satisfaction of the Army and the Service (Table PD 10). It is anticipated that updates to the fuel model and helicopter staffing guidelines may be made periodically and cooperatively by the Army and the Service as new information about fire rate of spread under various conditions becomes available. New information would not necessarily trigger reinitiation of formal consultation, as long as fire suppression helicopter staffing adjustments are made, to maintain equal or greater protection to the resources.

Table PD 10. Guinea grass fuel model parameters to be used to adjust Beavers (2001) GRASS 2 fuel model until future adjustments to the fuel model are made and accepted by the Army and Service.

Live Herbaceous Fuel Moisture (WIMS)	Wind Adjustment Factor	Fuel Bed Depth
120 % or higher	0.5	1.88 feet
100 – 120 %	0.5	2.71 feet
99% or lower	0.5	4.1 feet

At the time when the helicopter staffing requirements table was developed, limited fire behavior information was available for fires burning in guinea grass, particularly for grass with WIMS-calculated live herbaceous fuel moisture greater than 100 percent. Army wildland fire management staff are collaborating with fire behavior researchers from the U.S. Forest Service Pacific Southwest Research Station, the State, and the Center for Environmental Management of Military Lands to gather rate of spread data for headfires burning in mature guinea grass under various live herbaceous fuel moisture conditions. Actual rates of spread are expected to be lower than the rates of spread used to develop these helicopter staffing requirements under high live herbaceous fuel moisture conditions. When the Army has documented guinea grass rates of spread with various WIMS-calculated live herbaceous fuel moistures, particularly under high live herbaceous fuel moisture conditions, the Army will forward the updated fuel model information to the Service for review. Given mutually agreed upon fuel model parameters, the Army will develop updated fire suppression helicopter staffing requirements which provide for the containment of fires outside the firebreak road at acreages equal to or smaller than those which are predicted to occur given the current helicopter staffing requirements. The CONTAIN module of BehavePlus will be used to compare predicted fire acreages using the new fuel model and helicopter staffing, to the acreages in Table PD 11. Fire acreages at all wind speeds and fuel moisture conditions would be equal to or less than those presently predicted in Table PD 11. The updated helicopter staffing requirements will be submitted to the Service for review and concurrence. Updated helicopter staffing requirements, agreed to in writing by the Service field supervisor, will be appended to the Biological Opinion and will replace the requirements currently specified in Table PD 5. Updated helicopter staffing guidelines will not be instituted at Makua without this prior written approval of the Service.

We have been conservative in our application of the fuel model and Behave/CONTAIN fire spread model in some areas, but this is counterbalanced by some of the model's other limitations. Some of the assumptions we used result in predicted acreages larger than what we anticipate will occur. For instance, the smallest initial fire acreage permitted in the Behave/CONTAIN model is 0.04 ha (0.1 ac). Because fire spread will be slow in the winter, we anticipate that you will initiate suppression when fires are smaller than 0.04 ha (0.1 ac). Behave/CONTAIN assumes that the fire is burning over a homogeneous landscape of guinea grass. When the fire hits breaks in topography (i.e., when fires hit the top of C-Ridge) they slow. Larger fires will hit shrub/forest vegetation, which burns more slowly. There are large, continuous expanses of grass fuels in Makua Valley which would support large fire development. Fire acreages and suppression success are similar on flat ground to those in the fire acreage tables. On the other hand, BehavePlus/CONTAIN does not provide for changes in wind direction, spot fires (which are likely to occur when live herbaceous fuel moisture is less than 100 percent), or for multiple simultaneous fire ignitions (which may occur when tracers are being fired).

The predicted helicopter staffing appears to closely match the numbers of helicopters that were historically used to suppress fires at Makua outside the firebreak road. This included: zero helicopters: 14 percent of fires (fires close to road were suppressed by hand), one helicopter: 41 percent of fires, two helicopters: 10 percent of fires, three helicopters: 14 percent of fires, four helicopters: 7 percent of fires, 5 helicopters: 10 percent of fires, 7 helicopters: 3 percent of fires. In summary, 35 percent of Army-caused fires outside the firebreak road took four or more helicopters to suppress and almost all helicopters were UH-60 and CH-47 helicopters with 660 to 1,000 gallon buckets.

Anticipated Fire Acreage Examples: For planning purposes the CONTAIN module of BehavePlus fire behavior software was used to predict anticipated fire acreages for fires burning in guinea grass under various slope, fuel moisture and wind conditions. FireFamily Plus' NFDRS Calculator program was used to estimate Burning Index and tables were color-coded to indicate the fire danger which was most likely to occur under various fuel moisture and weather conditions. Examples of the results from these simulations are presented in Table PD 11.

Table PD 11: Examples of anticipated final acreages of fires outside the firebreak road, burning in thick guinea grass, burning under various fuel moisture and weather conditions, with standby helicopter response times of one full hour, based on CONTAIN module of BehavePlus fire behavior model.

Color shading in tables:

	Likely to be Green
	May be green or yellow, depending on other weather and fuel moisture factors
	Likely to be Yellow
	May be yellow or red, depending on other weather and fuel moisture factors
	Likely to be Red

Guinea grass fire: Live Herbaceous Fuel Moist 200%, Live Woody Fuel Moisture 200%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopter staffing: 22 ch/hr (0-5 mph winds), 33 ch/hr (6-10 mph), 41 ch/hr (11-15 mph), 42 ch/hr (>16 mph)					
	1-hour fuel moisture				
20-ft wind	**6%**	**8%**	**10%**	**12%**	**14%**
0 mph	Contained 6.1 ac	Contained 5.4 ac	Contained 4.8 ac	Contained 4.4 ac	Contained 4.0 ac
2 mph	Contained 6.4 ac	Contained 5.7 ac	Contained 5.1 ac	Contained 4.6 ac	Contained 4.2 ac
4 mph	Contained 7.6 ac	Contained 6.6 ac	Contained 5.9 ac	Contained 5.4 ac	Contained 4.9 ac
6 mph	Contained 7.7 ac	Contained 6.8 ac	Contained 6.1 ac	Contained 5.6 ac	Contained 5.2 ac
8 mph	Contained 9.7 ac	Contained 8.6 ac	Contained 7.7 ac	Contained 7.1 ac	Contained 6.5 ac
10 mph	Contained 12.4 ac	Contained 10.8 ac	Contained 9.7 ac	Contained 8.8 ac	Contained 8.1 ac
12 mph	Contained 13.8 ac	Contained 12.2 ac	Contained 11.0 ac	Contained 10 ac	Contained 9.1 ac
14 mph	Contained 17.0 ac	Contained 14.9 ac	Contained 13.3 ac	Contained 12.1 ac	Contained 11.0 ac
16 mph	Contained 20.4 ac	Contained 17.7 ac	Contained 15.8 ac	Contained 14.4 ac	Contained 13.0 ac
18 mph	Escaped	Contained 21.7 ac	Contained 18.9 ac	Contained 17.0 ac	Contained 15.4 ac
20 mph	Escaped	Escaped	Escaped	Contained 20.8 ac	Contained 18.2 ac

Guinea grass fire: Live Herbaceous Fuel Moist 150%, Live WDY FM 150-200%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopter staffing: 28 ch/hr (0-5 mph winds), 42 ch/hr (6-10 mph), 50 ch/hr (11-15 mph), 52 ch/hr (>16 mph)					
20-ft wind	**1-hour fuel moisture**				
wpeed	**6%**	**8%**	**10%**	**12%**	**14%**
0 mph	Contained 9.1 ac	Contained 7.9 ac	Conatined 7.1 ac	Conatined 6.5 ac	Contained 6.1 ac
2 mph	Contained 9.6 ac	Contained 8.3 ac	Contained 7.5 ac	Conatined 6.8 ac	Contained 6.4 ac
4 mph	Contained 11.3 ac	Contained 9.8 ac	Contained 8.8 ac	Conatined 8 ac	Contained 7.5 ac
6 mph	Conatined 14.5 ac	Contained 9.6 ac	Contained 9.1 ac	Conatined 8.4 ac	Contained 7.9 ac
8 mph	Contained 21.2 ac	Contained 12.1 ac	Contained 11.5 ac	Contained 10.6 ac	Contained 9.9 ac
10 mph	Contained 10.1 ac	Contained 15.3 ac	Contained 14.6 ac	Contained 13.3 ac	Contained 12.4 ac
12 mph	Contained 21.5 ac	Contained 18.8 ac	Contained 16.8 ac	Contained 15.4 ac	Contained 23.3 ac
14 mph	Contained 26.5 ac	Contained 23 ac	Contained 20.5 ac	Contained 18.8 ac	Contained 14.4 ac
16 mph	Contained 31.9 ac	Contained 27.4 ac	Contained 24.3 ac	Contained 22.2 ac	Contained 20.7 ac
18 mph	Escaped	Contained 35.3 ac	Contained 29.3 ac	Contained 26.5 ac	Contained 24.5 ac
20 mph	Escaped	Escaped	Escaped	Escaped	Contained 29.5 ac

Guinea grass fire: Live Herbaceous Fuel Moist 120%, Live WDY FM 120-190%,10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopter Staffing: 34 ch/hr (0-5 mph winds), 49 ch/hr (6-10 mph), 60 ch/hr (11-15 mph), 62 ch/hr (>16 mph)					
	1-hour fuel moisture				
20-ft wind	**6%**	**8%**	**10%**	**12%**	**14%**
0 mph	Conatined 12.3 ac	Conatined 10.6 ac	Contained 9.4 ac	Contained 8.6 ac	Contained 8.2 ac
2 mph	Contained 13 ac	Contained 11.2 ac	Contained 9.9 ac	Conatined 9 ac	Contained 8.6 ac
4 mph	Contained 15.4 ac	Contained 13.2 ac	Contained 11.7 ac	Conatined 10.6 ac	Contained 10.1 ac
6 mph	Contained 16.1 ac	Contained 13.9 ac	Contained 2.5 ac	Contained 2 ac	Contained 1.8 ac
8 mph	Contained 20.6 ac	Contained 17.8 ac	Contained 15.8 ac	Contained 14.4 ac	Contained 13.3 ac
10 mph	Contained 26.4 ac	Contained 22.7 ac	Contained 20 ac	Contained 18.1 ac	Contained 16.8 ac
12 mph	Contained 29.9 ac	Contained 25.8 ac	Contained 22.9 ac	Contained 20.8 ac	Contained 19.2 ac
14 mph	Contained 37 ac	Contained 31.7 ac	Contained 28 ac	Contained 25.4 ac	Contained 23.5 ac
16 mph	Contained 44.7 ac	Contained 37.9 ac	Contained 33.4 ac	Contained 30.1 ac	Contained 27.8 ac
18 mph	Escaped	Contained 49 ac	Contained 40.2 ac	Contained 36 ac	Contained 33 ac
20 mph	Escaped	Escaped	Escaped	Escaped	Contained 39.4 ac

Guinea grass fire: Live Herbaceous Fuel Moist 100%, Live WDY FM 100-170%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopter Staffing: 86 ch/hr (0-10 mph winds), 104 ch/hr (11-15 mph), 107 ch/hr (16 mph and higher)					
20-ft wind	1-hour fuel moisture				
wpeed	6%	8%	10%	12%	14%
0 mph	Contained 30.7 ac	Contained 26.2ac	Contained 23.0 ac	Contained 20.6 ac	Conatined 3.7 ac
2 mph	Contained 32.7 ac	Contained 27.9 ac	Contained 24.4 ac	Contained 21.9 ac	Conatined 20.0 ac
4 mph	Contained 40 ac	Contained 34.0 ac	Contained 29.6 ac	Contained 26.5 ac	Conatined 24.2 ac
6 mph	Contained 42.3 ac	Contained 36.0 ac	Contained 4.7 ac	Contained 4.0 ac	Conatined 3.6 ac
8 mph	Contained 55.6 ac	Contained 47.1 ac	Contained 41.4 ac	Contained 37.2 ac	Conatined 34.1 ac
10 mph	Contained 72.7 ac	Contained 61.2 ac	Contained 53.6 ac	Conatined 48 ac	Conatined 43.9 ac
12 mph	Contained 83.3 ac	Contained 71.3 ac	Contained 62.7 ac	Conatined 56.3 ac	Conatined 51.5 ac
14 mph	Contained 104.2 ac	Contained 88.7 ac	Contained 77.6 ac	Conatined 69.5 ac	Conatined 63.5 ac
16 mph	Contained 127.7 ac	Contained 107.3 ac	Contained 93.4 ac	Conatined 83.5 ac	Conatined 76.1ac
18 mph	Escaped	Contained 144.4 ac	Contained 113.4 ac	Conatined 100.3 ac	Conatined 91.1 ac
20 mph	Escaped	Escaped	Escaped	Escaped	Contained 109.1 ac

Guinea grass fire: Live Herbaceous Fuel Moist 80%, Live WDY FM 80-150%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopter staffing: 98 ch/hr (0-5 mph winds), 150 ch/hr (6-10 mph), 182 ch/hr (11-15 mph), 197 ch/hr (>16 mph)					
	1-hour fuel moisture				
20-ft wind	6%	8%	10%	12%	14%
0 mph	Contained 87.3 ac	Contained 74.0 ac	Contained 64.3 ac	Contained 9.9 ac	Contained 7.9 ac
2 mph	Contained 94.4 ac	Contained 79.8 ac	Contained 69.3 ac	Contained 61.4 ac	Contained 9.6 ac
4 mph	Contained 119.8 ac	Contained 100.8 ac	Contained 87.1 ac	Contained 77.0 ac	Contained 69.4 ac
6 mph	Contained 129.2 ac	Contained 110.3 ac	Contained 96.4 ac	Contained 86.0 ac	Contained 78.0 ac
8 mph	Contained 175.0 ac	Contained 148.8 ac	Contained 129.6 ac	Contained 115.3 ac	Contained 104.3 ac
10 mph	Contained 234.3 ac*	Contained 197.8 ac	Contained 171.5 ac	Contained 152.0 ac	Contained 137.2 ac
12 mph	Contained 274.3 ac*	Contained 232.9 ac*	Contained 202.6 ac*	Contained 180.1 ac	Contained 162.9 ac
14 mph	Contained 349.3 ac*	Contained 293.8 ac*	Contained 254.4 ac*	Contained 225.4 ac*	Contained 203.4 ac*
16 mph	Contained 417.6 ac*	Contained 348.8 ac*	Contained 301.5 ac*	Contained 267.0 ac*	Contained 240.9 ac*
18 mph	Escaped	Contained 453.7 ac*	Contained 367.8 ac*	Contained 322.7 ac*	Contained 289.9 ac*
20 mph	Escaped	Escaped	Escaped	Contained 406.7 ac*	Contained 347.7 ac*

* BehavePlus/CONTAIN assumes headfire burning in guinea grass on a 60% slope over the entire fire area. The south aspect of C-Ridge has an average percent slope of 60%, but it is only 200 acres in area. Fires larger than 200 acres will hit fuelbreaks and turn into flanking and backing fires once they crest C-Ridge. Therefore, fire acreages larger than 200 acres, and acreages of fires ignited close to the top of C-Ridge are overestimated by the model.

Guinea grass fire: Live Herbaceous Fuel Moist 60%, Live WDY FM 60-130%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopters: 120 ch/hr (0-5 mph winds), 183 ch/hr (6-10 mph), 223 ch/hr (11-15 mph), 236 ch/hr (>16 mph)					
	1-hour fuel moisture				
20-ft wind	6%	8%	10%	12%	14%
0 mph	Contained 128.6 ac	Contained 108.6 ac	Contained 93.3 ac	Contained 13.4 ac	Contained 10.7 ac
2 mph	Contained 139.0 ac	Contained 117.2 ac	Contained 101.2 ac	Contained 89.3 ac	Contained 12.6 ac
4 mph	Contained 176.6 ac	Contained 148.1 ac	Contained 127.5 ac	Contained 112.0 ac	Contained 100.2 ac
6 mph	Contained 191.2 ac	Contained 162.8 ac	Contained 141.7 ac	Contained 125.7 ac	Contained 113.1 ac
8 mph	Contained 259.5 ac*	Contained 219.9 ac*	Contained 190.7 ac	Contained 168.7 ac	Contained 151.5 ac
10 mph	Contained 347.9 ac*	Contained 292.8 ac*	Contained 252.8 ac*	Contained 222.8 ac*	Contained 199.6 ac
12 mph	Contained 406.6 ac*	Contained 344.3 ac*	Contained 298.4 ac*	Contained 263.9 ac*	Contained 237.0 ac*
14 mph	Contained 518.2 ac*	Contained 434.6 ac*	Contained 374.9 ac*	Contained 330.4 ac*	Contained 296.0 ac*
16 mph	Contained 620.5 ac*	Contained 516.7 ac*	Contained 445 ac*	Contained 391.9 ac*	Contained 351 ac*
18 mph	Escaped	Contained 668.7 ac*	Contained 542.8 ac*	Contained 473.7 ac*	Contained 422.5 ac*
20 mph	Escaped	Escaped	Escaped	Contained 587.1 ac*	Contained 505.9 ac*

* BehavePlus/CONTAIN assumes headfire burning in guinea grass on a 60% slope over the entire fire area. The south aspect of C-Ridge has an average percent slope of 60%, but it is only 200 acres in area. Fires larger than 200 acres will hit fuelbreaks and turn into flanking and backing fires once they crest C-Ridge. Therefore, fire acreages larger than 200 acres, and acreages of fires ignited close to the top of C-Ridge are overestimated by the model.

Guinea grass fire: Live Herbaceous Fuel Moist 50%, Live WDY FM 50-100%, 10-hr = 1hr+1, WAF = .5, wind across 60% slope Fire Suppression Helicopters: 135 ch/hr (0-5 mph winds), 206 ch/hr (6-10 mph), 250 ch/hr (11-15 mph), 270 ch/hr (>16 mph)					
	1-hour fuel moisture				
20-ft wind	6%	8%	10%	12%	14%
0 mph	Contained 160.5 ac	Contained 135.4 ac	Contained 117.0 ac	Contained 103.1 ac	Contained 92.2 ac
2 mph	Contained 173.5 ac	Contained 146.2 ac	Contained 126.1 ac	Contained 111.0 ac	Contained 99.3 ac
4 mph	Contained 220.7 ac*	Contained 184.9 ac	Contained 158.9 ac	Contained 139.4 ac	Contained 124.3 ac
6 mph	Contained 239.1 ac*	Contained 203.4 ac*	Contained 176.8 ac	Contained 156.6 ac	Contained 140.6 ac
8 mph	Contained 324.7 ac*	Contained 274.9 ac*	Contained 238.2 ac*	Contained 210.3 ac*	Contained 188.5 ac
10 mph	Contained 435.4 ac*	Contained 366.2 ac*	Contained 315.8 ac*	Contained 277.9 ac*	Contained 248.5 ac*
12 mph	Contained 510.4 ac*	Contained 431.7 ac*	Contained 373.8 ac*	Contained 329.9 ac*	Contained 295.6 ac*
14 mph	Contained 650.9 ac*	Contained 545.3 ac*	Contained 469.8 ac*	Contained 413.3 ac*	Contained 369.5 ac*
16 mph	Contained 780.4*	Cantained 648.9 ac*	Contained 558.0 ac*	Contained 490.6 ac*	Contained 438.4 ac*
18 mph	Escaped	Contained 851.3 ac*	Contained 681.0 ac*	Contained 593.3 ac*	Contained 527.8 ac*
20 mph	Escaped	Escaped	Escaped	Contained 736.8 ac*	Contained 632.2 ac*
* BehavePlus/CONTAIN assumes headfire burning in guinea grass on a 60% slope over the entire fire area. The south aspect of C-Ridge has an average percent slope of 60%, but it is only 200 acres in area. Fires larger than 200 acres will hit fuelbreaks and turn into flanking and backing fires once they crest C-Ridge. Therefore, fire acreages larger than 200 acres, and acreages of fires ignited close to the top of C-Ridge are overestimated by the model.					

The Army will invite the Service to a meeting or after action review within one week of the occurrence of all fires burning outside the firebreak road at Makua or any fire burning any area within any of the on-site or off-site Makua Implementation Plan management units. The Army will evaluate the fire suppression response and final fire acreage of all fires in relation to the fire size predicted by the CONTAIN module of BehavePlus. If the sizes of fires suppressed outside the firebreak road at Makua are larger than the sizes predicted by the Contain module of BehavePlus (see Table PD 11), or fire rate of spread is faster than predicted, the Army will work with the Service to develop new, increased, helicopter staffing requirements which are acceptable to both agencies. If rate of spread data indicates that guinea grass burns more slowly than the fuel model predicts, helicopter staffing decreases may be considered. Adjustments to the guinea grass fuel model and fire suppression helicopter staffing requirements may be appended to this Biological Opinion, for use at Makua, given the concurrence of both the Army and the Service.

STATUS AND ENVIRONMENTAL BASELINE OF SPECIES AND CRITICAL HABITAT - OVERVIEW

Introduction

This section presents the biological and ecological information relevant to formulating the Service's Biological Opinion covering 38 plant taxa, Oahu tree snail, and Oahu elepaio. We also include information on designated critical habitat for 36 endangered and threatened plant taxa and for the Oahu elepaio. These listed resources are present within the action area on Army-owned or leased lands on Makua, and on adjacent State, city/county, and private lands.

For the "status" descriptions for each species, we discuss life history, habitat, distribution, abundance, threats, conservation needs, constituent elements of critical habitat, and other factors necessary for survival, as the basis for analyses in later sections. For the "environmental baseline" descriptions, we document this information for species and critical habitats within the action area. We also attempt to rank the background risk of extinction for each covered species, as a basis for evaluating project effects on individual fitness, population viability, and the likelihood of species persistence. Demographic data is utilized where available to generally indicate whether a species is increasing, declining, or maintaining its numbers. For most of the species covered in this Biological Opinion, little is known about the critical factors that determine status, such as intrinsic rates of population increase or decline, survivorship, minimum viable population size, and estimated mean time to extinction.

Owing to the lack of population viability data for the covered species, we qualitatively categorize whether baseline conditions for plant species are currently at a moderate, high, or very high risk of extinction. By definition, any species listed as endangered is "in danger" of extinction throughout all or a significant portion of its range. The Army's proposed Makua Implementation Plan Addendum identifies 28 endangered plant taxa in need of stabilization (Table SB 1). For the purposes of this Biological Opinion, these species are considered to have a high background extinction risk because intensive management is needed to ensure their persistence. Of these target taxa, 12 taxa are considered even more "at risk" due to their restricted distribution (i.e., only or mostly on Oahu), low numbers, and limited reproduction. As such, these 12 species have been identified for expedited stabilization (see Table SB 1). These expedited stabilization taxa are defined as those with (1) fewer than 100 total individuals remaining; or (2) more than 100 individuals, but with fewer than half of their mature individuals needed to fulfill numerical stabilization criteria; or (3) more than 100 individuals, but with half or more of their mature individuals within the action area (i.e., at risk of training-related wildfire). Expedited stabilization taxa were identified in 2006, during inter-agency negotiation of conservation measures to avoid jeopardy, and are based on the Army's 2005 Status Update Report (U.S. Army Garrison 2005b). Expedited stabilization taxa are also characterized by fewer than three population units not exceeding numeric criteria for stabilization, no population units outside the action area exceeding numeric criteria for stabilization, and a declining number of individuals or maintenance of numbers primarily through augmentation; in addition, they may face uncontrollable threats, such as rat and slug predation or black twig borer infestation. There are 12 non-stabilization species, (i.e., species that are not included for stabilization management in the Makua Implementation PlanAddendum, owing to relatively large range-wide numbers and some occurrences with larger individual numbers, are considered at "moderate" risk of extinction) (see Table SB 1).

Table SB 1. Status of Plant Taxa Within the Action Area

Species	Status						
	Critical Habitat & Plants	Plants Only	Critical Habitat Only	Stabilization	Expedited Stabilization	Non-Stabilization	Kaluakauila-Punapohaku Fire Minimization Measures
Abutilon sandwicense		●				●	
Alectryon macrococcus var. *macrococcus*		●		●			
Bonamia menziesii	●					●	●
Cenchrus agrimonioides var. *agrimonioides*	●			●			
Chamaesyce celastroides var. *kaenana*	●			●			●
Chamaesyce herbstii	●				●		
Colubrina oppositifolia			●				
Ctenitis squamigera		●				●	
Cyanea grimesiana ssp. *obatae*	●				●		
Cyanea longiflora	●				●		
Cyanea superba ssp. *superba*	●				●		
Cyrtandra dentata	●			●			
Delissea subcordata	●				●		
Diellia falcata	●					●	
Dubautia herbstobatae	●			●			
Euphorbia haeleeleana	●					●	●
Flueggea neowawraea	●			●			
Gouania vitifolia	●				●		
Hedyotis degeneri var. *degeneri*	●			●			
Hedyotis parvula	●			●			
Hesperomannia arbuscula	●			●			
Hibiscus brackenridegei ssp. *mokuleianus*	●				●		
Isodendrion laurifolium			●				
Isodendrion longifolium			●				
Isodendrion pyrifolium			●				

Table SB 1 (Continued). Status of Plant Taxa Within the Action Area

Species	Status						
	Critical Habitat & Plants	Plants Only	Critical Habitat Only	Stabilization	Expedited Stabilization	Non-Stabilization	Kaluakauila-Punapohaku Fire Minimization Measures
Lepidium arbuscula		●				●	
Lobelia niihauensis		●				●	
Mariscus pennatiformis			●				
Melanthera tenuifolia		●		●			
Melicope pallida			●				
Neraudia angulata	●				●		
Nototrichium humile	●			●			●
Peucedanum sandwicense		●				●	
Phyllostegia kaalaensis	●				●		
Plantago princeps var. *princeps*	●			●			
Pritchardia kaalae		●		●			
Sanicula mariversa	●				●		
Schiedea hookeri	●					●	●
Schiedea kaalae	●			●			
Schiedea nuttallii	●				●		
Schiedea obovata		●			●		
Silene lanceolata		●				●	
Solanum sandwicense			●				
Spermolepis hawaiiensis	●					●	
Tetramolopium filiforme		●		●			
Viola chamissoniana ssp. *chamissoniana*		●		●			

Five endangered taxa, *Nototrichium humile, Chamaesyce celastroides* var. *kaenana, Bonamia menziesii, Euphorbia haeleeleana* and *Schiedea hookeri* occur in the Kaluakauila Management Unit or in adjacent areas (see Table SB 1). This management unit and the areas in close proximity are surrounded by the high fire risk zone. The dominant vegetative cover of this area is non-native fire prone grasses. A significant percentage of the known individuals (State-wide and/or island-wide) of these taxa occur within, or near to, this management unit. Therefore, the loss of individuals of these taxa from within and around the Kaluakauila Management Unit would significantly reduce the probability these taxa would persist over the long-term. For some taxa, the probability of persistence across their total range would be reduced, for other taxa the continued persistence in a significant portion (Oahu) of their range would be reduced.

In the case of four of the taxa, *Nototrichium humile, Chamaesyce celastroides* var. *kaenana, Euphorbia haeleeleana* and *Schiedea hookeri,* a significant portion of the total known number of individuals (approximately 20 percent, 40 percent, 40 percent and 20 percent, respectively) are at considerable risk of being destroyed by training related wildfires, in and around the Kaluakauila Management Unit. In addition, 20 percent of the known individuals of *Bonamia menziesii* on Oahu occur within Kaluakauila Management Unit and thus stand a significant risk of being destroyed by training related wildfires.

The environmental baseline description for each species documents its status within the action area. For each species, we determine the importance of individual fitness to population viability within the action area, and to the survival and recovery of the species as a whole. The threat of training-related wildfire in the action area is estimated according to the location of individuals within zones of high, low, and very low fire risk. For many species, the available GIS database information is too coarse to enumerate all individuals that will be exposed to fire within these zones. For example, data points located on map boundaries between fire risk zones may represent individuals within either or both of the zones. In these cases, the Service and the Army have agreed that all individuals at zone boundaries will be counted within the higher fire risk zone.

The consultation period for this Biological Opinion has required significant inter-agency negotiation of complex fire protection and impact minimization measures over about 18 months. During that time, we periodically received updated information about the proposed action from the Army. The new information required continual revision of our fire model simulations to delineate the action area and recommend appropriate conservation measures. Also during the consultation period, the Army continued to implement stabilization measures and monitor target species. The Army's 2006 status report, which was distributed in October 2006 and reviewed by the inter-agency Makua Implementation Team, is the best available information on the status and baseline of the 29 species that need stabilization covered in this opinion. Problems arise because the action area for this consultation differs from that used in 2003 to develop the Makua Implementation Plan, and the Army monitors stabilization species within that 2003 action area. The current action area excludes some parts of the 2003 action area that encompassed population units of stabilization species, and elsewhere expands to new areas that contain additional occurrences of listed species (e.g., *Gouania vitifolia*). Few covered species are affected by the change in action area boundaries, and the numbers of individuals that are included or excluded based on differences in the 2003 and 2007 action areas are not significant.

For stabilization species, our baseline determinations are based on current status within the action area monitored in the Army's 2006 status report, even though this creates inaccuracies for some species that have fewer individuals or population units within the current action area than in the 2003 action area. In some cases, detailed analysis of GIS information and reference to Army Natural Resources field data sheets was used to determine numbers of individuals within various areas, and in these cases, these additional sources of data are cited. Many listed plants, especially many of the most highly at-risk taxa, occur along the Makua Valley rim and beyond, in mixed native and non-native forest that has been excluded from the new action area. Thus, baselines for some species are slightly overestimated for the action area considered in this opinion. To the best of our knowledge, the action area baseline has not been underestimated for any of the covered species. In addition, the reader also should note that status/baseline tables in this opinion do not allow for direct comparison of numbers due to varying survey effort across years.

General Environmental Baseline Factors

General environmental baseline factors that are uniform for all species and critical habitats in the action area are summarized jointly below. These factors include past and present impacts of all Federal, State, or private actions, and other human activities in the action area; anticipated impacts of all proposed Federal projects in the action area that have already undergone formal consultation; and impact of State or private actions that are contemporaneous with the consultation. Details on unique or important factors for particular species or critical habitats are discussed more fully in the species-specific status and baseline descriptions that follow.

Past and present impacts of all human activities in the action area include historical land use in the Makua and Kahanahaiki valleys (now located within Makua) and adjacent lands, as described in the Army's draft environmental impact statement for the proposed action (U.S. Army Corps of Engineers 2005). Before human settlement on Oahu, vegetation in leeward lowland areas such as Makua probably consisted of dry grasslands and shrublands, and shrublands and forests in some areas may have extended all the way to the coast (Cuddihy and Stone 1990). In leeward Oahu valleys, native Hawaiians altered lowland vegetation by cultivation of sweet potato, taro, and other crops using shifting cultivation (slash-and-burn) and extensive irrigation systems (Cuddihy and Stone 1990). In the 1800s, non-native Hawaiian farmers grew watermelon, pumpkin, cucumber, tobacco, and cotton in the Makua and Kahanahaiki valleys (U.S. Army Corps of Engineers 2005). Ranching impacted all or parts of Makua and Kahanahaiki, and the adjacent Keawaula and Kuaokala areas, from 1864 until the Army took over control of the area in 1941. At that time, the Army relocated residents before using Makua and Kahanahaiki valleys for "simulated battle training." The Army has been training at Makua ever since.

Other past and present human activities in the action area include fires set by human carelessness and arson, habitat lost to development, and trampling of native vegetation along roads and trails. Major threats to listed resources in the action area related to human activities are non-native plants and animals introduced by Polynesian and Euro-American settlers. These invasive species include ungulates (pigs, goats, cattle, and sheep), rodents (rats and mice), insects (black-twig borer, Chinese rose beetle, two-spotted leaf hopper, long-legged ant, white fly, and scales), other invertebrates (snails and slugs), disease pathogens (avian malaria and avian pox), and hundreds of invasive weed species that compete with native plants for growing space, light, water, and soil nutrients. These threat factors are tabulated for each species in Appendix E and are discussed in the "General Effects" section. Details on unique or particularly dangerous threats are discussed as appropriate in the species-specific status and baseline descriptions.

Anticipated impacts of all proposed Federal projects in the action area that have already undergone formal consultation include activities covered by existing Biological Opinions that are still in effect (Service 1999b, 2001a, 2001b, 2003a, 2004a). The actions covered by these opinions are similar to the proposed action except for the inclusion of the following weapon systems in this opinion; tracers, TOWs, 155 mm HE howitzer artillery, 2.75-caliber helicopter-launched rockets, and Javelin anti-tank missiles. As a result of previous Biological Opinions, the Army developed and began implementing a Wildland Fire Management Plan and fire danger rating system to reduce the risk of fire ignition and spread, and a Makua Implementation Plan to stabilize 29 target taxa. Impacts associated with Army training were expected to continue indefinitely while the Army continued to implement these conservation measures. Ongoing stabilization actions for target taxa are based on management of species-level population units and ecosystem-level management units, and include ungulate exclusion, weed control, rat control at elepaio nesting sites, augmentation and reintroduction of endangered plants, propagule collection for *ex situ* genetic storage, and captive propagation of *Achatinella mustelina* tree snails. During 1999-2003, the Army implemented certain "urgent actions" needed to address threats to listed resources while the Makua Implementation Plan was being developed, and has been monitoring and managing non-stabilization species in the action area since 1999.

The fire history of military training at Makua is described in the General Effects – Fire Suppression section of this Biological Opinion. Training at Makua was suspended in 1998 due to a third-party lawsuit but was resumed in October 2001 under a settlement agreement and stipulated order. Under the settlement agreement, limited live-fire training (18 CALFEXs and other training exercises) was conducted between October 2001 and October 2005, in conformance with the Service's existing Biological Opinions. During the 2001-2005 limited training period, four fires were ignited. Two small fires, caused by an AT-4 anti-tank rocket and oxidation of old white phosphorus rounds, were immediately extinguished without damage to listed resources (U.S. Army Corps of Engineers 2005). An approximately 640-ha (2,100-ac) fire from an escaped July 2003 prescribed burn, jumped the firebreak road and burned uncontrolled for three days damaging several listed species and critical habitats. An approximately 121-ha (300-ac) fire attributed to white phosphorus ignition escaped the firebreak road in August 2005, but did not affect listed resources. Thus, even with reduced training levels since 1998, fires associated with military activities have continued to impact Makua.

The impacts of State or private actions that are contemporaneous with the consultation include conservation programs on State-owned lands within and adjacent to the action area (Kuoakala Forest Reserve, Mokuleia Forest Reserve, Makua-Keaau Forest Reserve, and Pahole Natural Area Reserve). Population units of listed species, management units for ecosystem-level stabilization actions, and critical habitat units are also located on city/county and private lands. Some State lands within and adjacent to the action area are public hunting areas where non-native ungulates are impacting native plants. In addition, city/county and private lands contain endangered species population units and management units, including Honolulu Board of Water Supply lands and lands managed by The Nature Conservancy of Hawaii. Other privately owned lands are not managed for endangered species conservation and are threatened by pigs, goats, and invasive weeds. All non-Army lands within and adjacent to the action area have been impacted by agricultural and ranching activities, habitat loss and development, trampling of native vegetation along roads and trails, and fires set by carelessness and arson.

Critical Habitat This section also presents the biological and ecological information relevant to formulating the Service's Biological Opinion covering designated critical habitat for 36 endangered and threatened plant taxa and for the Oahu elepaio. Specific areas within the geographical area occupied by a species were designated as critical habitat because they contain physical or biological features essential to species conservation that may require special management considerations or protection. In some cases, specific areas outside the geographical area occupied by the species were also designated as critical habitat because they are essential to species conservation. Critical habitat is designated within the action area on State, city/county, and private lands. Critical habitat for plants is not designated on Army lands owing to various exclusions pursuant to sections 3 and 4 of the Endangered Species Act. However, critical habitat for the Oahu elepaio is designated on Army lands within Makua, as well as on State, city/county, and private lands within the action area.

Army-controlled (owned or leased) lands on Oahu and the island of Hawaii were excluded from plant critical habitat designation because they were covered by Integrated Natural Resource Management Plans that adequately address the species' needs, and because the benefit of exclusion outweighed the benefit of inclusion. According to the Sikes Act Improvement Amendments of 1997, each military installation must develop an Integrated Natural Resource Management Plan that reflects a mutual agreement between the Service and the State concerning conservation, protection, and management of fish and wildlife resources. Although the Service determined that lands within Makua were essential for the conservation of many plant species, management and conservation of these lands were already addressed in the Makua Integrated Natural Resource Management Plan.

For the critical habitat status and environmental baseline descriptions, we discuss the constituent elements necessary for species conservation as the basis for analyses in later sections. The status sections describe the entire designated critical habitat in terms of the biological and physical features that are essential to the conservation of the species, with emphasis on critical habitat units designated on Oahu. Although the primary constituent elements of the critical habitat are identified, little information is available on the current condition of these constituent elements. The environmental baseline sections describe these issues for critical habitat units within the action area, the relationship of action area critical habitat to the entire designated critical habitat, and the conservation value of the critical habitat to the species. The environmental baseline descriptions also address the ability of action area critical habitat to provide a portion of the habitat essential for the conservation of one or more populations. The general environmental baseline factors for critical habitat in the action area are the same as those discussed above for covered species.

For the critical habitats covered in this Biological Opinion, the best available scientific and commercial information is insufficient to determine their current condition within the action area and range-wide. In general, however, most native Hawaiian ecosystems are threatened by the same suite of factors related to habitat loss and the introduction and spread of non-native invasive species. Because these threats are fairly uniform, they are described in general below and are not discussed in the species-specific status and baseline descriptions. Likewise, conservation needs of critical habitat are much the same for all covered species, and are not discussed in the species-specific descriptions.

Threats to Critical Habitat The major threats to all covered species, including plants and the Oahu elepaio, are similar within the action area as well as range-wide. Herbivory (including fruit and seed predation) of listed plants and associated native plants by non-native ungulates, rats, snails, slugs, and insects reduce the overall ecosystem health of critical habitat. Feral ungulates (cattle, goats, sheep, pigs, and deer) also degrade critical habitat by trampling and uprooting vegetation, increasing erosion, and spreading seeds of invasive plants. Some critical habitats also are vulnerable to occasional random environmental disturbances such as landslides, rockfalls, erosion, hurricanes, and flooding, and to human-related disturbances such as fire, military training, and trampling along trails. For some species of multi-island distribution, threats to critical habitat vary slightly among island units; for example, non-native deer and mouflon sheep (absent from Oahu) may threaten the status of critical habitat units on other islands.

Non-native plants that compete with and replace native plants are a major threat to critical habitat through exploiting and pre-empting available light, growing space, water, and nutrients. Competition by aggressive non-native plants for primary constituent elements results in habitat degradation and reduced vigor of native plants. Although the particular invasive plant species differ in various critical habitat units, some of the major invasive plants affecting listed species and critical habitats throughout the action area include *Ageratina riparia*, *Aleurites moluccana*, *Blechnum appendiculatum*, *Clidemia hirta*, *Ficus macrophylla*, *Ficus microcarpa*, *Grevillea robusta*, *Kalanchoe pinnata*, *Lantana camara*, *Melinis minutifolia*, *Paspalum conjugatum*, *Passiflora suberosa*, *Psidium* sp., *Rivina* sp., *Schinus terebinthifolius*, *Syzygium cumini*, and *Toona ciliata* (Makua Implementation Team 2003; 68 FR 35950).

Conservation Needs for Critical Habitat The conservation needs for plant and elepaio critical habitats in the action area are fairly uniform. Restoration of fire-altered native habitats to native vegetation is the primary need to prevent further invasion of fire-tolerant invasive grasses. The removal and control of ungulates, rats, and invasive plants would eliminate a major threat to the conservation value of critical habitat and would enhance the quantity, quality, and availability of primary constituent elements. Ungulate control usually requires fence construction and removal of animals from fenced exclosures. Rat control currently involves establishing and monitoring individual toxicant bait stations and trapping grids, which is labor intensive and expensive. Aerial broadcast of rodenticide baits would facilitate cost-effective treatment of large areas. The Environmental Protection Agency is evaluating the approval of a label registration for aerial rodenticide broadcast in Hawaii. Research and implementation of control techniques for non-native invertebrates such as slugs, snails, black twig borer, two-spotted leafhopper, and Chinese rose beetle would reduce habitat degradation by these pests. Invertebrate control is complicated by the need to develop methods that do not also harm native tree snails and insects but is mandatory to aide in the persistence of these native threatened populations.

Status of the Species– *Abutilon sandwicense* (No Common Name)

Species Description *Abutilon sandwicense* is a member of the Malvaceae (mallow) family. It is a shrub that grows to 3 m (9 ft) in height. Leaf blades are pale green, shallowly dentate, and covered with sparse pubescence. Flowers are solitary and pendulous and located in the leaf axils. The fruit develops into a capsule that matures in about six weeks. The sepals are greenish yellow in color, with the petals being bright green to reddish brown with green venation. This species is distinguished from others in the genus by its green or reddish-brown tipped petals that exceed the sepals (Wagner et al 1999).

Listing Status *Abutilon sandwicense* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was state listed as endangered at the same time. A recovery plan for Waianae plants included this species (Service 1995a), and critical habitat was designated on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Abutilon sandwicense* is endemic to the island of Oahu. Historically, *A. sandwicense* was known from nearly the entire length of the Waianae Mountains, from Makaleha Valley to Nanakuli Valley (Service 1998a). When the species was listed in 1991, there were 14 occurrences with 300 to 400 individuals. Currently there are 14 occurrences with approximately 400 individuals on Federal, State, private, city, and county lands. Trends in numbers and distribution are difficult to discern, owing to inconsistent identification of occurrences and monitoring efforts. No range-wide surveys have been conducted for this species. According to the most recent information available, only one stabilization population has more than 50 mature, reproducing individuals.

Table SB 2. Range-wide Distribution of *Abutilon sandwicense.*

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Number of Known Individuals</th></tr>
<tr><th>1991
(1)</th><th>1995
(2)</th><th>2003
(3)</th><th>2003
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kahanahaiki</td><td>--</td><td>--</td><td>--</td><td>1-2</td><td>0</td><td>0/1[‡]</td></tr>
<tr><td>Keaau</td><td>--</td><td>--</td><td>--</td><td>1</td><td>1</td><td>1/10</td></tr>
<tr><td>Kaluakauila</td><td>--</td><td>--</td><td>--</td><td>--</td><td>0/6
[0/6][§]</td><td>0/22</td></tr>
<tr><td>Palikea Gulch portion of Kaawa to Puulu[¶]</td><td>--</td><td>--</td><td>--</td><td rowspan="2">63-83</td><td>10/3</td><td>--</td></tr>
<tr><td>West Makaleha</td><td>--</td><td>--</td><td>--</td><td>0/2</td><td>--</td></tr>
<tr><td>East Makaleha</td><td>--</td><td>--</td><td>--</td><td>--</td><td>2/2</td><td>--</td></tr>
<tr><td>Halona</td><td>--</td><td>--</td><td>--</td><td>1</td><td>1/ 4</td><td>--</td></tr>
<tr><td>Ekahanui and Huliwai</td><td>--</td><td>--</td><td>--</td><td>17</td><td>17/15
[0/65]</td><td>--</td></tr>
<tr><td>Kaawa to Puulu</td><td>--</td><td>--</td><td>--</td><td>--</td><td>34/84</td><td>--</td></tr>
<tr><td>Makaha Mauka</td><td>--</td><td>--</td><td>--</td><td rowspan="2">50-100</td><td>40/100</td><td>--</td></tr>
<tr><td>Makaha Makai</td><td>--</td><td>--</td><td>--</td><td>50/7</td><td>--</td></tr>
<tr><td>Nanakuli</td><td>--</td><td>--</td><td>--</td><td>30</td><td>30</td><td>--</td></tr>
</table>

North Mikilua	--	--	--	2	2	--
South Mikilua	--	--	--	4	4	--
Waianae Kai	--	--	--	6	6	--
Total Individuals	**300-400**	**<300**	**253-263**	**180-246**	**407** (189/212)† [0/71]	**424** (166/258)

Shaded population units are inside the action area.
‡Mature/immature individuals
¶Schofield Barracks Military Reservation
§[Augmented and or reintroduction]
†Total (mature/immature)

(1) Listing rule (56 FR 55770)
(2) Recovery plan (Service 1998a)
(3) Critical habitat rule (68 FR 35950)
(4) Oahu Biological Opinion (Service 2003a)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology *Abutilon sandwicense* typically grows on steep slopes in dry forests between 300 and 600 m (1,000 and 2,000 ft) elevation. Associated native species include *Antidesma pulvinatum, Diospyros sandwicensis, Elaeocarpus bifidus, Eugenia reinwardtiana, Hibiscus arnottianus, Metrosideros polymorpha, Myrsine lanaiensis, Nestegis sandwicensis, Pipturus albidus, Pisonia* sp., *Pittosporum* sp., *Pleomele* sp., *Psydrax odorata, Rauvolfia sandwicensis, Reynoldsia sandwicensis,* and *Sapindus oahuensis* (Hawaii Natural Heritage Program 2001). *Abutilon sandwicense* has been observed flowering in winter and spring. Although seedlings are often initially abundant, few plants appear to survive to maturity for unknown reasons. Little else is known about the phenology, pollinators, seed dispersal agents, longevity, specific environmental requirements, or limiting factors for this species (59 FR 32932).

Threats to the Species *Abutilon sandwicense* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The unique threats to *A. sandwicense* are the black twig borer (*Xylosandrus compactus*) and the Chinese rose beetle (*Adoretus sinicus*). Human activity along a trail in Honouliuli Preserve also threatens individuals in a nearby occurrence. There is one population with more than 50 mature, reproducing individuals (the suggested minimum number for stabilization populations for this species (Service 1995a) of *A. sandwicense* on Makaha Makai.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Abutilon sandwicense* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *A. sandwicense* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. Currently, the Army does not actively manage this species in the Makua and

Schofield Barracks action areas (Service 2003a). Surveys should be conducted to identify and assess the effects of the black twig borer and/or Chinese rose beetle on this species.
Ongoing Conservation Actions Various conservation management actions have been implemented for *Abutilon sandwicense* since it was listed as endangered. About 22 individuals (four percent of all remaining individuals) of this species occur in the fenced Kaluakauila Management Unit where they will benefit from population unit and/or ecosystem-level protection. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, in order to recover rare species and restore native habitats; this plan will benefit any *A. sandwicense* within the preserve. This species is represented in the following *ex situ* collections: 45 leaf samples in micropropagation (Harold L. Lyon Arboretum), 42 plants in botanical garden collections (Amy Greenwell Ethnobotanical Garden and Waimea Valley Audubon Center), 457 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and five seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b, U.S. Army Garrison 2005d).

Environmental Baseline of the Species

Status of the Species in the Action Area The three occurrences of *Abutilon sandwicense* in the action area total approximately 35 individuals or about 8 percent of the for this species total population (U.S. Army Garrison 2005c) (see Table SB 2). One occurrence with approximately 22 immature individuals is located within the Kaluakauila fenced unit. The other two occurrences are not fenced and these occurrences are not actively managed by the Army. *Abutilon sandwicense* plants in the action area are located in areas at risk from training-related wildfire. About 22 individuals occur in the high fire risk zone, one in the low fire risk zone and 12 individuals occur in the very low fire risk zone. About four percent of the species' totals range-wide are located in the high fire risk zone.

Threats to the Species The primary threats to *Abutilon sandwicense* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. All individuals of *A. sandwicense* are at risk from training-related wildfires. Particularly the 22 immature plants in the Kaluakauila Management Unit since this unit is located in the high fire risk zone. One mature plant occurs in the low fire risk zone and 12 individuals occur in the very low fire risk zone.

Conservation Needs of the Species *Abutilon sandwicense* does not require stabilization by the Army because less than 50 percent of all remaining individuals are located within the action area. A post-fire revegetation plan and site-specific fuels modification plan are needed where *A. sandwicense* is present in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species No conservation actions are currently being implemented specifically for *Abutilon sandwicense* in the Makua action area. However, this species benefits from ecosystem-level management in the fenced Kaluakauila Management Unit where non-native ungulates and weeds are controlled. In addition, fuels modification along the Kaluakauila ridgeline reduces the risk of fire in the management unit (K. Kawelo, pers. comm. 2004; Service 2004a). This species is represented in the following *ex situ* collections: 45 leaf samples in micropropagation (Harold L. Lyon Arboretum), 42 plants in botanical garden collections (Amy Greenwell Ethnobotanical Garden and Waimea Valley Audubon Center), 457 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and five seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b, U.S. Army Garrison 2005d).

Status of the Species – *Alectryon macrococcus* var. *macrococcus* (Mahoe)

Species Description *Alectryon macrococcus* var. *macrococcus* is a tree in the soapberry family (Sapindaceae) that reaches heights of 11 m (34 ft). Fully mature trees are usually multi-trunked with a sinewy appearance and reddish-brown branches. The leaves are compound, with two to five pairs of leaflets, each of which measures 10 to 28 cm (3.9 to 10.9 in) long. The undersides of the leaves of a young *A. macrococcus* var. *macrococcus* plant have dense brown hairs. The flowers are borne in panicles up to 30 cm (11.7 in) long. Flowers are either perfect (possessing male and female reproductive parts) or staminate (possessing only male reproductive parts). The roundish fruits are 2.5 to 7 cm (0.9 to 2.7 in) in diameter and, when ripe, the hard rind of the fruit will open to expose the contents. The hard rind consists of the aril, or the fleshy part of the fruit, and a single flattish seed (Wagner et al 1999).

Listing Status *Alectryon macrococcus* var. *macrococcus* was federally and State listed as endangered on May 15, 1992 (57 FR 20772). A recovery plan was prepared for this species in 1997 (Service 1997). Critical habitat was designated for *A. macrococcus* var. *macrococcus* on Kauai; February 27, Molokai; March 18, Maui; May 14, and Oahu on June 17, 2003 (60 FR 51398).

Historic and Current Distribution *Alectryon macrococcus* var. *macrococcus* is endemic to the Hawaiian Islands and is known from Kauai, Oahu, Molokai, and Maui. Trends in distribution indicate approximately 79 plants are thought to remain on Kauai on the western side of the island from Olokele Canyon to Kalalau Valley. *Alectryon macrococcus* var. *macrococcus* has always been considered relatively rare on Molokai (10 individuals) and Maui (approximately 21 individuals). On Oahu, it is known primarily from the Waianae Mountains, where it has been recorded throughout the mountain range on both windward and leeward sides. There are two historical records of the taxon in the Koolau Mountains where it is no longer found. *Alectryon macrococcus* var. *macrococcus* is present throughout its historic range except for the Koolau Mountains. Currently, there are approximately 372 wild mature plants, 10 wild immature plants, and 14 augmented immature plants State-wide. Known locations on Kauai include: Haeleele (three wild mature plants), Kalalau (11 wild mature plants), and Koaie (65 wild mature plants), totaling 79 individuals. There are 21 individuals located on Maui at Haena Nui (15 wild mature plants), Honokowai (two wild mature plants), Iao (two wild mature plants), Launiupoko (one wild mature plant), and Waikapu (one wild mature plant). Ten individuals are located on Molokai at Kahuaawi (one wild mature plant), Kaunakakai to Kawela (eight wild mature plants), and Kawela and Makolelau (one wild mature plant). Approximately 244 plants remain in the Waianae Mountains in the following locations: Kahanahaiki to West Makaleha (42 wild mature, four wild immature, plus four augmented immature plants), Makua (33 wild mature plants), South Mohiakea (six wild mature plants), Central Kaluaa to Central Waieli (46 wild mature and 10 wild immature plants), Makaha (63 wild mature, five wild immature, and two seedlings), and Waianae Kai (six wild mature plants) (U.S. Army Garrison 2006c) (Table SB 3). It is estimated that the residual plants for this species reside only on Federal and State lands. On Oahu, demographic data reveals 90 percent of *Alectryon macrococcus* var.

macrococcus individuals are mature plants, and one percent are immature augmentations. Thus, *A. macrococcus* var. *macrococcus* on Oahu is characterized by only two populations units with more than 25 mature reproducing individuals and several other occurrences with fewer than 25 mature reproducing individuals that represent about 80 percent of all State-wide individuals.

Table SB 3. Range-wide Distribution of *Alectryon macrococcus* var. *macrococcus*.

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Number of Known Individuals</th></tr>
<tr><th>1992
(1)</th><th>1997
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kahanahaiki*</td><td rowspan="4">--</td><td rowspan="4">--</td><td>2</td><td rowspan="4">43/4
[0/6] [§]</td><td rowspan="4">42/4
[0/6]</td><td>1/0
[0/4]</td></tr>
<tr><td>Kapuna*</td><td>6</td><td>0/0</td></tr>
<tr><td>Pahole*</td><td>7</td><td>4/0</td></tr>
<tr><td>West Makaleha*</td><td>40/4[‡]</td><td>37/4</td></tr>
<tr><td>Makua*</td><td>--</td><td>--</td><td>15</td><td>17</td><td>20</td><td>33/0</td></tr>
<tr><td>Central Kaluaa to Central Waieli*</td><td>--</td><td>--</td><td>50/3</td><td>50/1</td><td>56/2
[0/8]</td><td>20[(7)]/10</td></tr>
<tr><td>South Mohiakea (SBMR)</td><td>--</td><td>--</td><td>16/1</td><td>15/1</td><td>6</td><td>6/0</td></tr>
<tr><td>Makaha*</td><td>--</td><td>--</td><td>75/2</td><td>35</td><td>62/7</td><td>63/7</td></tr>
<tr><td>Waianae Kai</td><td>--</td><td>--</td><td>16</td><td>16</td><td>5</td><td>6/0</td></tr>
<tr><td>Other Surveyed Locations</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>48/4</td></tr>
<tr><td>Total Individuals on Oahu</td><td>~500</td><td>~500</td><td>347
(337/10)[†]</td><td>188
(176/6)
[0/6]</td><td>218
(191/13)
[0/14]</td><td>247
(218/25)
[0/4]</td></tr>
<tr><td>Total Individuals on Other Islands</td><td><110</td><td>~100</td><td>110</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Total Individuals State-wide</td><td>610</td><td>600</td><td>447/10</td><td>--</td><td>--</td><td>357</td></tr>
</table>

Shaded Population Units are inside the action area.
[*]Stabilization population units (Kahanahaiki, Kapuna, Pahole, and West Makaleha are considered one stabilization population unit.)
[‡]Mature/immature individuals
[¶]Schofield Barracks Military Reservation
[§][Augmented and or reintroduced]
[†]Total (mature/immature)

(1) Listing rule (57 FR 20772)
(2) Recovery plan (Service 1997)
(3) Critical habitat rule (68 FR 35969), Makua Implementation Plan (Makua Implementation Team 2003) and Oahu Biological Opinion (Service 2003a)
(4) MIP Addendum and 2004 status update (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c, 2006d)
(7) S. Ching (U.S. Army Garrison, pers. comm. 2007).

<u>Ecology</u> *Alectryon macrococcus* var. *macrococcus* is a relatively slow-growing, long lived tree that grows in xeric to mesic sites and is adapted to periodic drought. Despite appearing

relatively healthy, a substantial percentage of the trees flower but never bear fruit. Although the cause of this is not known, it may be that some trees only bear flowers that are functionally male. There is little information on growth rates of wild plants and their age of maturation. However, two trees in cultivation have been observed to flower for the first time when they were about 15 years old. At that age they were approximately 6 m (20 ft) tall and were single-trunked, with the trunks measuring about 14 cm (5.5 in) in diameter. Wild trees undoubtedly live for decades, based on observed growth rates and tree sizes. Pollination of the taxon is probably carried out by insects. No recruitment has been observed and most remaining individuals are likely to be old, senescent individuals that will die without replacement. Flowering cycles, seed dispersal agents, and specific environmental requirements are unknown (Makua Implementation Team 2003). Other demographic information for *A. macrococcus* var. *macrococcus* in the wild is unknown. *Alectryon macrococcus* var. *macrococcus* grows on slopes, ridges, or in gulches within mesic lowland forests between elevations of 367 and 941 m (1,204 and 3,086 ft) (Service 2003b).

Threats to the Species *Alectryon macrococcus* var. *macrococcus* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described under "General Status and Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In addition, *A. macrococcus* var. *macrococcus* is vulnerable to rat predation on seeds, fruits and other plant parts; depressed reproductive vigor; loss of pollinators; and stochastic events (Service 1999b; Hawaii Natural Heritage Program 2001; Service 2003b).

The primary threat to *Alectryon macrococcus* var. *macrococcus* on Oahu is an invasive insect, the black twig borer (*Xylosandrus compactus*), which was introduced in 1961. The black twig borer burrows into the branches and introduces a pathogenic fungus. The end result is severe pruning of the host that often kills branches or the whole plant. All known plants of this species suffer from slight to severe defoliation and reduced vigor due to the infestation of this non-native insect. The Chinese rose beetle, introduced in 1896, also defoliates portions of the plant and could result in death once the tree is weakened by other threats (Mau and Kessing 2004; Nelson and Davis 1972; Hara and Beardesly 1979).

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Alectryon macrococcus* var. *macrococcus* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). The recovery plan for this species identifies several conservation actions necessary to recover this species such as fencing, weed control, outplanting of local genetic material and rodent control (perhaps only seasonally during fruiting season). Surveys and monitoring should be initiated to determine the detrimental effects of the black twig borer and rodents to this species. Sites that are relatively free from these invasive pests should be considered prime candidates for protection. Extreme care should be taken not to introduce the black twig borer into a pest-free area with propagated material of *A. macrococcus* var. *macrococcus* species (Service 2003b). At least 50 mature, reproducing individuals are needed per population unit to attain stability for long-lived individuals.

Ongoing Conservation Actions Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Alectryon macrococcus* var. *macrococcus, w*hich are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The U.S. Navy is conducting non-native plant control in areas where *A. macrococcus* var. *macrococcus* is located at the Naval Magazine Lualualei. Recreational hunting is allowed on Navy lands to control feral pigs. Feral ungulate control is being conducted on both Army and State lands in the Waianae Mountains. This species is being propagated at the Army Environmental nursery and the Lyon Arboretum on Oahu, the Hawaii Division of Forestry and Wildlife nursery on Kauai, and the National Tropical Botanical Garden on Maui and Kauai. Introductions/augmentations have been conducted over the last ten years into Kahanahaiki Gulch. Seeds are in storage facilities at the Lyon Arboretum and the National Tropical Botanical Garden. The Service is not currently aware of any other conservation efforts for this species (Service 2003b; L. Durand, pers. comm. 2004; Hawaii and Pacific Plant Recovery Committee. 2007; Service 2005a).

Alectryon macrococcus var. *macrococcus* is represented in several *ex situ* collections, including nine embryos in micropropagation (Harold L. Lyon Arboretum), one apical or lateral vegetative bud in micropropagation (Harold L. Lyon Arboretum), two cuttings in a nursery (Army Environmental Division, Oahu), three plants in a botanical garden (Waimea Valley Audubon Center), six seeds in a nursery (Harold L. Lyon Arboretum), 174 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 10 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b, U.S. Army Garrison 2005d). *Alectryon macrococcus* var. *macrococcus* can be successfully propagated from seed, air layers and cuttings.

Environmental Baseline of the Species

Status of the Species in the Action Area Approximately 30 percent of all known individuals of *Alectryon macrococcus* var. *macrococcus* are located within the action area in the Ohikilolo and Kahanahaiki to West Makaleha population units. Trends in numbers suggest an overall decline in numbers of this species since the 1990s. *Alectryon macrococcus* var. *macrococcus* individuals have increased since 2003 due to augmentation of immature plants and discovery of new mature individuals in the wild (U.S. Army Garrison 2004a). Approximately 90 percent of the total individuals in the action area are mature and 10 percent are augmented immature individuals.

Of the approximately 40 *Alectryon macrococcus* var. *macrococcus* individuals in the action area, almost all are located outside of the high fire risk zone. *Alectryon macrococcus* var. *macrococcus* is characterized by 18 occurrences, each with fewer than 25 mature, reproducing individuals.

Threats to the Species in the Action Area The primary threats to *Alectryon macrococcus* var. *macrococcus* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Additional threats that affect this species include rat predation and reduced plant vigor due to infestation of the black twig borer (U.S. Army Garrison 2003b). *Alectryon macrococcus* var. *macrococcus* has a background risk of species extinction and these additional threats decrease its potential for long-term persistence.

Conservation Needs of the Species in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Alectryon macrococcus* var. *macrococcus* because no populations meet the minimum requirement for plant stabilization. To be considered stable, *A. macrococcus* var. *macrococcus* must meet the criteria required for stability of a long-lived perennial. Stabilization measures include habitat and population management of three population units, augmentation of existing populations, collection of full *ex situ* representation of wild stock on Oahu, rat control, and research and implementation of black twig borer control methods (U.S. Army Garrison 2003b). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species in the Action Area</u> The Makaha and Makua population units are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). Twenty-four individuals of *A. macrococcus* var. *macrococcus* are within fenced units and benefit from ungulate exclosure. Most of the trees in the Kahanahaiki to West Makaleha population unit show a significant amount of black twig borer damage. Some of the Kahanahaiki trees are fenced, while none of the Upper Kapuna or West Makaleha trees are fenced. Weed control has only occurred around the Kahanahaiki reintroductions. Seven air layers were set up on two different trees in the Makua population unit in February 2005. As of June, only one of the air layers exhibited any sign of callusing. Rats are controlled in the vicinity of some trees in Makaha and central Kalua'a in conjunction with Oahu elepaio management, and have activated baiting grids in 2006 around small fruited populations in lower Makua (U.S. Army Garrison 2006b). Natural Resources Staff had observed a significant decline in the numbers of known trees in the South Mohiakea population unit. Controlling rats with bait is not feasible at this site due to problems with access. Air layers have been done with some success and the propagules are established at the Army Nursery (U.S. Army Garrison 2005c).

The Army has prepared a fire management plan for the Kaluakauila Management Unit. Rats are controlled within the exclosure. Fuel modification is being conducted along the ridgeline between the management unit and the installation boundary to reduce the risk of fire and to protect the plants in this management unit. In addition, the Natural Resources Staff has begun collecting genetic material for *Alectryon macrococcus* var. *macrococcus* and has sent seeds to Lyon Arboretum for a propagation experiment. Unfortunately, genetic storage goals for *A. macrococcus* var. *macrococcus* are less than one percent complete (1/300) (U.S. Army Garrison 2003b).

Status of the Species and Critical Habitat – *Bonamia menziesii* (No Common Name)

<u>Species Description</u> *Bonamia menziesii*, a member of the Convolvulaceae (morning-glory) family, is a vine with twining branches up to 10 m (33 ft) long that are fuzzy when young. The leathery, oblong to oval leaves measure 3 to 9 cm (1.2 to 3.5 in) in length and 1 to 4-cm (0.4 to 1.6 in) in width. The upper leaf surface is usually hairless or covered with sparse hairs and the lower surface is covered with tomentose. The white to greenish funnel-shaped flowers are produced singly or in clusters of three on stalks with tiny bracts (modified leaves) at the base of each stalk. Stamens usually have glandular hairs at their bases. The flower has two styles, which are separate or partly fused. The fruits are tan or yellowish brown and contain one or two oval seeds imbedded in black pulp. This species is the only member of the genus that is endemic

to the Hawaiian Islands and differs from other genera in the family by its two styles, longer stems and petioles, and rounder leaves (Wagner et al 1999; Austin 1990).

Listing Status *Bonamia menziesii* was federally listed as endangered on November 10, 1994 (59 FR 56333), and was State listed as endangered at the same time. A recovery plan for multi-island plants included this species (Service 1999a), and critical habitat was designated on June 17, 2003 (68 FR 35950).
Historic and Current Distribution Historically, *Bonamia menziesii* was known from scattered locations on Kauai, the Koolau and Waianae Mountains of Oahu, several locations on Molokai, one location on west Maui, and eastern Hawaii. Currently, this species is extant on Kauai, Oahu, Lanai, Maui, and Hawaii. *Bonamia menziesii* is known from many occurrences on these five islands with the largest number of extant individuals located on Kauai comprising several thousand individuals. At least a dozen occurrences are known from Kalalau, upper Waioli Valley, scattered across the north coast from Limahuli, Hanakapiai to Milolii, Kawaiula Valley, Hipalau Valley, Paaiki Valley, Mount Kahili, and Hono O Na Pali Natural Area Reserve on State and private land, and Wahiawa drainage on private land totaling more than 1,000 individuals. There are 12 occurrences on Oahu that total fewer than 60 plants located both the Waianae and the Koolau Mountains (U.S. Army Garrison 1999a). These occurrences are found in Niu Valley, Makaleha Valley, Makua-Keaau Ridge, Wailupe, Waialae Nui-Kapakahi Ridge and Kapakahi Gulch, Kaluakauila Gulch, Keawaula, Hawaii Loa Ridge and Kului Gulch, Nanakuli Valley, Kuaokala, Halona, Waialae Iki, Kapuna Gulch, Mikilua, Waianae Kai, and Alaiheihe Gulch on Federal, State, and private lands (EDA Database 2001; GDSI 2001; Hawaii Natural Heritage Program 2001). On Lanai, *B. menziesii* is known from three scattered occurrences: about six individuals at Kaa, two individuals on Puhielelu Ridge, and four individuals at Paomai, on private land. On Maui, one occurrence of a single individual is known from private land on the western slopes of West Maui, and three to five occurrences with nine to 14 individuals are located on private and State land on East Maui. On the island of Hawaii, a single occurrence of at least three individuals is located at Kaupulehu on private land (Hawaii Natural Heritage Program 1995; Lorence and Flynn 1991; S. Perlman and K. Wood, pers. comm. 1997). Recent survey data from the island of Oahu suggests the number of individuals and occurrences is decreasing on the island. There are no stabilization population units exceeding minimum numerical criteria (i.e., greater than 50 reproducing individuals) on Oahu. Even though there are thought to be several thousand individuals on the island of Kauai, these populations are not managed or monitored so their status is unknown.

Table SB 4. Range-wide Distribution of *Bonamia menziesii*.

Population Units	**Number of Known Individuals**						
	1991 (1)	**1999** (2)	**1999** (3)	**2002** (4)	**2003** (5)	**2005** (6)	**2006** (7)
Kaluakauila	--	--	--	--	--	10/0‡	10/0
Makua	--	--	--	--	--	1/0	--
Keaau	--	--	--	--	--	1/0	--
Alaiheihe	--	--	--	--	--	5/0	--
Kaawa	--	--	--	--	--	10/0	--
Kapuna	--	--	--	--	--	5/0	--
Kaumokunui	--	--	--	--	--	1/0	--

Keawaula	--	--	--	--	--	5/0	--
Kuaokala	--	--	--	--	--	10/0	--
Lualualei	--	--	--	--	--	2/0	--
Nanakuli	--	--	--	--	--	10/0	--
Waianae Kai	--	--	--	--	--	1/0	--
Total Individuals Oahu	**<150**	**100-150**	**100-150**	**<100**	**<100**	**~60**	**28** (27/1)†
Total Population Units State-wide	--	31-44	>31	--	--	--	--
Total Individuals State-wide	**~200**	**1,000s**	**1,000s**	**1,000s**	**1,000s**	**1,000s**	--

Shaded population units are inside the action area.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR55770)
(2) Recovery plan (Service 1999a)
(3) Makua Biological Opinion (Service 1999b)
(4) Critical habitat rule (67 FR 37108)
(5) Critical habitat rule (68 FR 35950)
(6) Army re-initiation request (U.S. Army Garrison 2005c)
(7) Army database (U.S. Army Garrison 2006d)

Ecology *Bonamia menziesii* is found on steep slopes as well as on level ground in dry to mesic forest and sometimes in wet forest, between the elevations of 150 and 625 m (490 and 2,050 ft). Associated species include *Metrosideros polymorpha*, *Psydrax odorata*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Myoporum sandwicense*, *Nestegis sandwicensis*, *Pisonia umbellifera*, and *Sapindus oahuensis.* Little is known about the life history, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors of this species (Service 1999a).

Threats to the Species *Bonamia menziesii* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. An alien beetle (*Physomerus grossipes*), which has recently become established on Oahu, is potentially a significant threat to *B. menziesii* (D. Orr, pers. comm. 1999).

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Bonamia menziesii* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *B. menziesii* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua and Schofield

Barracks action areas (Service 2003a). Surveys should be conducted to identify and assess the effects of the alien beetle on this species.

Ongoing Conservation Actions The *Bonamia menziesii* plant on the Navy's Lualualei Naval Reservation has been fenced for protection from cattle. A program of alien plant removal within the exclosure is ongoing (J. Moribe, pers. comm. 1997). Most of the *B. menziesii* at Kanepuu Preserve on Lanai are found within fenced exclosures. In addition, the Nature Conservancy of Hawaii has implemented a fuel reduction treatment strategy for the Kanepuu Preserve on Lanai that includes mowing, at least yearly, portions of the seven distinct fenced units (C. Cory, pers. comm. 1999). The Kanepuu Preserve fire protection plan is updated each year and incorporates the participation of local, State, and private agencies (A. Remec, pers. comm. 1999). It is expected that these actions may enhance conservation of the *B. menziesii* plants found there. *Bonamia menziesii* has been successfully propagated at the Lyon Arboretum's micropropagation laboratories, at the Waimea Arboretum, and the National Tropical Botanical Garden (Koob 1996; M. Chapin, pers. comm.1997; G. Koob pers. comm. 1997; D. Orr, pers. comm. 1997). Currently, approximately 25 individuals exist in cultivation (Koob 1996; M. Chapin, pers. comm. 1997; D. Orr, pers. comm. 1997). Reintroduction of cultivated individuals to the wild has not been attempted.

Critical Habitat Description A total of 1,795 ha (4,415 ac) has been designated as critical habitat for *Bonamia menziesii* and is separated into nine distinct units on four Hawaiian Islands. Two critical habitat units are located on Kauai and include approximately 513 ha (1,267 ac), one is on Maui and includes 536 ha (1,325 ac), five units are on Oahu and include 608 ha (1,503 ac), and one is on Hawaii and includes 163 ha (402 ac). Critical habitat has been designated primarily on State lands (e.g., Lihue-Koloa Forest Reserve on Kauai, Kanaio Natural Area Reserve on Maui, and Kaena Point State Park and Nanakuli Forest Reserve on Oahu). Each of the critical habitat units provides habitat for one population of at least 300 mature, reproducing individuals of *B. menziesii* (68 FR 9116, 68 FR 25934, 68 FR 35950, 68 FR 39624).

The primary constituent elements of the units on Oahu include steep slopes or level ground in dry or mesic forest in open or closed canopy containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Dianella sandwicensis*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Erythrina sandwicensis*, *Hedyotis terminalis*, *Leptecophylla tameiameiae*, *Melicope* sp., *Metrosideros polymorpha*, *Myoporum sandwicensis*, *Nestegis sandwicensis*, *Pisonia* sp., *Pittosporum* sp., *Pleomele* sp., *Pouteria sandwicensis*, *Psydrax odorata*, *Rauvolfia sandwicensis*, *Sapindus oahuensis*, *Sicyos* sp., *Sida fallax*, or *Waltheria indica;* at elevations between 81 and 658 m (266 and 2,158 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area   Currently, less than one percent of the known *Bonamia menziesii* plants are found within the Makua action area. Ten individuals are located in Kaluakauila and two individuals are found on the lower end of Ohikilolo Ridge (U.S. Army Garrison 2005c). None of these occurrences exceed minimum numerical criteria for a stabilization population unit. The individuals within the action area represent approximately 43 percent of the individuals on the island of Oahu. The Kaluakauila population unit with the highest density (10 individuals) is located in the high fire risk zone.

Status of the Critical Habitat in the Action Area   Two percent (28 ha; 69 ac) of the critical habitat for *Bonamia menziesii* on the island of Oahu is located in two units within the Makua action area. Eight ha (20 ac) are in the high fire risk zone and 20 ha (49 ac) are in the low fire risk zone. These critical habitat units together provide habitat for the conservation of one population of at least 300 mature, reproducing individuals of *B. menziesii*. It is estimated that only one-quarter of the critical habitat within the Makua action area for this species has a native plant component of more than 75 percent (U.S. Army Garrison 1999a; K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area   The primary threats to *Bonamia menziesii* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. There are roughly 60 individuals of *B. menziesii* remaining on the island of Oahu with 12 in the Makua action area. There is a risk of losing a significant proportion of this species from the island of Oahu since 10 individuals of *B. menziesii* are located in the high fire risk zone. Less than one percent of the designated critical habitat on Oahu for this species is located in the high fire risk zone.

Conservation Needs of the Species and Critical Habitat in the Action Area   Conservation actions that should be implemented for the recovery of *Bonamia menziesii* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *B. menziesii* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua and Schofield Barracks action areas (Service 2003a).

Ongoing Conservation Actions for the Species and Critical Habitat within the Action Area   A portion (less than one percent) of critical habitat in the Makua action area is in the Kaluakauila Management Unit. The Army has prepared a fire management plan for this management unit to reduce the vulnerability of these plants from training related fires. In addition, the unit is fenced, and non-native plants and rats are controlled within the exclosure. Individuals within these fenced units will benefit from ungulate enclosure and from ecosystem level management.

Status of the Species and Critical Habitat – *Cenchrus agrimonioides* var. *agrimonioides* (Kamanomano)

Species Description *Cenchrus agrimonioides* var. *agrimonioides* is a perennial bunchgrass in the Poaceae (grass) family. An individual plant usually consists of few to many stems originating from a common base. Stems have been observed in the Waianae Mountains with lengths up to 2 m (6.6 ft), but they are usually only 0.5 m (1.6 ft) in length. Initially upright or at an angle, the stems recline on the ground as they lengthen. The flowers are encased in spiny burs borne on slender spikes that measure 5 to 10 cm (2 to 4 in) long. Each bur contains two flowers, one fertile and one sterile. The fertile flowers are perfect (possessing male and female reproductive parts) (Wagner et al 1999).

Listing Status *Cenchrus agrimonioides* var. *agrimonioides* was federally listed as endangered on October 10, 1996 (61 FR 53108), and state listed as endangered in Hawaii at the same time. A recovery plan was prepared for this species in July 1999 (Service 1999b), and critical habitat was designated on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Cenchrus agrimonioides* var. *agrimonioides* is endemic to the Hawaiian Islands. Historically, *C. agrimonioides* var. *agrimonioides* occurred on Oahu, Maui, Lanai, and Hawaii. It has been collected from four general areas: the Waianae Mountains of Oahu, West Maui (where it was recently discovered in 1996), the south slope of Haleakala on East Maui, and the island of Lanai. It was reported from the island of Hawaii in the 1800s, but no specimens from that island are known to exist in herbarium collections today. When this species was listed in 1996, there were six occurrences totaling fewer than 100 individuals State-wide, including one occurrence from the Kanaio Natural Area Reserve on Maui and the remainder on Oahu. Trends in numbers indicate an increase since listing State-wide (Service 2004b). In the U.S. Army Garrison status report (2005c), the Army lists 529 plants from four population units in the Waianae Mountains. These population units include: Kahanahaiki and Pahole (71 mature, 31 immature, and 47 seedlings, plus 192 augmented mature, 47 augmented immature and one augmented seedling), Central Ekahanui (30 mature, three immature, and 16 seedlings, plus 56 augmented mature plants), Makaha and Waianae Kai (14 mature plants), and South Huliwai (21 mature plants) (Table SB 5). State-wide occurrences of *Cenchrus agrimonioides* var. *agrimonioides* are known from Federal, State, city/county, and private lands (61 FR 53108).

On Oahu, about 85 percent of the total *Cenchrus agrimonioides* var. *agrimonioides* individuals are mature plants, seven percent are naturally recruited seedlings or immature plants, and seven percent are immature augmentations (U.S. Army Garrison 2006c). *Cenchrus agrimonioides* var. *agrimonioides* is characterized by one stabilization population unit on Oahu (Kahanahaiki and Pahole population unit) that exceeds the 50 mature, reproducing individuals threshold, representing about 60 percent of all individuals from the island.

Table SB 5. Range-wide Distribution of *Cenchrus agrimonioides* var. *agrimonioides.*

Population Units	**Number of Known Individuals**					
	1996 (1)	**1999** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kahanahaiki and Pahole*	--	23	28/9‡	66/23 [182/57]§	71/75 [202/42]	71/31 [245/54]

East Makaleha	--	6	--	--	--	--
Makaha*	--	10	5/3	9/2	13/4	14/0
Waianae Kai*	--		4			
Central Ekahanui*	--	--	20	30/3	30/19 [6/27]	30/19 [56/0]
South Huliwai	--	--	27	18	21	21/0
Kaluaa	--	--	--	--	--	[0/163]
Total Individuals on Oahu	**<100**	**<100**	**103** (91/12)†	**390** (123/28) [182/57]	**510** (135/98) [208/69]	**704** (136/50) [301/217]
Total Individuals on Other Islands	--	--	**7** (7/0)	--	--	--
Total Population Units State-wide	--	--	--	--	--	--
Total Individuals State-wide	**610**	**600**	**457** (447/10)	--	--	--

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
§[augmented and or reintroduced]
†Total (mature/immature)

(1) Listing rule (61 FR 53108)
(2) Recovery plan (Service 1999a)
(3) Critical habitat rule (68 FR 35950) and MIP (MIT 2003)
(4) MIP Addendum and 2004 status update (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c, 2006d)

Ecology *Cenchrus agrimonioides* var. *agrimonioides* is usually found on ridges and on upper gulch slopes, often in the understory of mesic forests. Recorded elevations for this taxon range from 560 to 872 m (1,830 to 2,860 ft) (61 FR 53108). A specimen collected in 1912 from the "Leilehua Plain" indicates that the taxon may also have occurred in lower and drier locations than where it is known today (U.S. Army Garrison 2003b).

Cenchrus agrimonioides var. *agrimonioides* reproduction appears to be mostly sexual as reproduction of the plants by vegetative means is seldom observed. As with most grasses, *C. agrimonioides* var. *agrimonioides* is wind-pollinated. Isolated cultivated plants have been observed to self-pollinate and produce viable seeds. Flowering has been reported from January through July. The spiny burs that contain the seeds of this taxon stick to the fur of mammals or the feathers of birds. With the complete absence of ground mammals in pre-human Hawaii, it is hypothesized that these burrs may have been dispersed by the many now-extinct species of flightless Hawaiian birds (Makua Implementation Team 2003). Certain plants currently in cultivation are four years old and still vigorous. Other demographic information for *C. agrimonioides* var. *agrimonioides* in the wild is unknown, including the species' longevity in the wild, which is assumed to be less than 10 years since it is a relatively small, non-woody plant (U.S. Army Garrison 2003b).

Threats to the Species *Cenchrus agrimonioides* var. *agrimonioides* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described under the "General

Status and Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In addition, the Makaha and Waianae Kai occurrences are threatened by trampling from hikers, as most of the plants in this area are found along the edge of a major trail. Additional threats to plants include cattle and axis deer grazing on Maui (U.S. Army Garrison 2003b).

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Cenchrus agrimonioides* var. *agrimonioides* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). The recovery plan for this species identifies important conservation actions which include protection from fire, maintenance of adequate genetic stock, fencing, non-native plant control, and outplanting of local genetic material to enhance existing populations and establish new populations. In addition, surveys of the northwestern Hawaiian Islands of Laysan, Kure, and Midway and collection of genetic material from any discovered plants should be conducted (Service 1999b).

Ongoing Conservation Actions Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Cenchrus agrimonioides* var. *agrimonioides* which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). One stabilization population (Kahanahaiki and Pahole population unit) with approximately 300 individuals now occurs largely through the efforts of outplanting by the U.S. Army. This species is represented in the following *ex situ* collections: 134 cuttings in a nursery (Army Environmental Division, Oahu), seven mature fruits in storage or awaiting processing at a nursery (Army Environmental Division, Oahu), three plants in a botanical garden (Waimea Valley Audubon Center), 937 ungerminated seeds in nurseries (Army Environmental Division, Oahu and Harold L. Lyon Arboretum), and 8,471 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b; U.S. Army Garrison 2005d). A long-range management plan for Honouliuli Preserve has been drafted, which will include actions for non-native plant management, ungulate control, fire control, rare species recovery, and native habitat restoration. It is expected that these actions will benefit *C. agrimonioides* var. *agrimonioides* within the preserve (Makua Implementation Team 2003; Service 2005b; U.S. Army Garrison 2005d).

Critical Habitat Description Critical habitat was designated for this species on May 14, 2003, on Maui and on June 17, 2003, on Oahu. A total of 1,242 ha (3,069 ac) in six separate units has been designated for *Cenchrus agrimonioides* var. *agrimonioides*. Two critical habitat units totaling 355 ha (878 ac) were designated on the island of Maui and include State (Kanaio Natural Area Reserve, West Maui Forest Reserve) and private lands. A total of 886 ha (3,068 ac) in four units was designated on Oahu on State (Mokuleia Forest Reserve, Waianae Forest Reserve, Kaala Natural Area Reserve) and private lands (Honouliuli Preserve). Each of the critical habitat units on Maui and three of the units on Oahu provide habitat for one population, and one critical habitat unit on Oahu provides habitat for four populations of *C. agrimonioides* var. *grimonioides*. To meet recovery goals, each population should be represented by at least 300 mature, reproducing individuals (68 FR 35950).

The primary constituent elements for the units on Oahu include dry ridges, upper slopes, or ridges in lowland mixed mesic forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Bobea* sp., *Carex wahuensis*, *Chamaesyce multiformis*, *Coprosma* *foliosa*, *Diospyros sandwicensis*, *Eragrostis variabilis*, *Gahnia beecheyi*, *Leptecophylla tameiameiae*, *Metrosideros polymorpha*, *Nestegis sandwicensis*, *Psychotria* sp., or *Psydrax odorata*. *Cenchrus agrimonioides* grows on Oahu at elevations between 357 and 874 m (1,171 and 2,867 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat See the introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section. An additional threat to this species is trampling by humans (68 FR 35950).

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Approximately 57 percent of all known individuals of *Cenchrus agrimonioides* var. *agrimonioides* on the island of Oahu are located within the action area, within the Kahanahaiki to Pahole population units. Trends in total number of individuals indicate an overall increase in the population from approximately 25 to approximately 400 individuals from 1999 to 2006. Of the approximately 400 individuals in the action area, approximately 300 have been planted as augmentations (Service 2005b, U.S. Army Garrison 2005c, 2005d). Approximately 194 individuals occur in the low fire risk zone and approximately 207 occur in the very low fire risk zone.

Status of Critical Habitat in the Action Area Fifteen percent (189 ha; 467 ac) of the critical habitat designated for *Cenchrus agrimonioides* var. *agrimonioides* is located in one unit within the Makua action area. This critical habitat is a portion of a larger, 529 ha (1,306 ac) critical habitat unit, that extends outside the Makua action area. Located in the northeastern portion of the action area, the entire critical habitat unit is in the two low fire risk zones with 14.8 ha (36.7 ac) in the low and 174 ha (430 ac) in the very low fire risk area. The entire critical habitat unit was designated to provide habitat for the conservation of four populations, with at least 300 mature, reproducing individuals of *C. agrimonioides* var. *agrimonioides* (68 FR 35950). It is estimated that more than one-half of the critical habitat is located in an area with a minimum of 50 percent native plant cover (U.S. Army Garrison 2003b; L. Durand, pers. comm. 2004; K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Cenchrus agrimonioides* var. *agrimonioides* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In addition, as a grass, *C. agrimonioides* var. *agrimonioides* is vulnerable to grazing pressure from feral ungulates and training related wildfires (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004; 68 FR 35950).

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Cenchrus agrimonioides* var. *agrimonioides* because no stabilization populations that meet minimum numeric criteria exist outside the Makua action area. Three population units have been identified for stabilization. This taxon will be stabilized because fewer than three stabilization population units exist outside of the Army action area. To be considered numerically stabilized *C. agrimonioides* var. *agrimonioides* must meet the criteria required for stability of a short-lived perennial including 50 mature, reproducing individuals per population and threats abated. Species stabilization measures include: habitat and population management of three population units, augmentation of existing populations, collection of full *ex situ* representation of wild stock on Oahu; non-native plant control, and ungulate control (U.S. Army Garrison 2003b).

Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat Within the Action Area</u> Eighty-six percent (235 ha; 581 ac) of the critical habitat for *Cenchrus agrimonioides* var. *agrimonioides* is located in designated management units (Lower and Upper Kapuna, Pahole, and West Makaleha) on Oahu. This species is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). The Kahanahaiki Management Unit is fenced and ungulates are excluded. A portion of Upper Pahole Management Unit is fenced, and fencing is planned for Upper Kapuna and West Makaleha Management Units (U.S. Army Garrison 1999a; U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004). Other conservation activities include non-native plant removal, application of rodenticide, fuel modification, habitat restoration, and black twig borer and slug control (U.S. Army Garrison 1999a; U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004). There are seven naturally occurring populations, and two large augmentation sites of C. *agrimonioides* var. *agrimonioides* in the Kahanahaiki and Pahole management units. Three of the Kahanahaiki sites are located inside the Kahanahaiki fence; the fourth has one mature, two immature, and one seedling, and is outside the fence. All of the Pahole locations are within the exclosure. This population unit has more than 50 reproducing individuals and all threats have been controlled. Natural Resources Staff and the Natural Area Reserve System specialists collected seeds and conducted weed control in 2005. Seed collected from the two Pahole *in situ* sites will be propagated and outplanted into a new reintroduction site in Pahole in 2006-2007, pending State permission (U.S. Army Garrison 2006c). Natural Resources Staff outplanted 60 plants from the Kahanahaiki stock into Pahole in December 2000. This reintroduction has flourished and 51 F1 generation plants on-site are either immature or have already matured. Genetic storage goals for *C. agrimonioides* var. *agrimonioides* are less than one percent complete. Weed control and monitoring are conducted at reintroduction sites established in Kahanahaiki to Pahole population unit (U.S. Army Garrison 2006c).

Status of the Species and Critical Habitat – *Chamaesyce celastroides* var. *kaenana* (Akoko)

<u>Species Description</u> *Chamaesyce celastroides* var. *kaenana,* a member of the spurge family (Euphorbiaceae), is a low-growing prostrate or upright shrub approximately 1 to 2 m (3.3 to 6.6 ft) tall. The stems have milky sap and are thick and knobby. The leaves, which fall off during the dry season, are mostly hairless and are arranged in two opposite rows along the stem; they are 20 to 65 mm (0.8 to 2.6 in) long, 8 to 20-mm (0.3 to 0.8 in) wide, and are widest at the tip. The flowers are borne on compact side branches, each of which bears 5 to 10 cyathia (specialized flower-like inflorescences with a single central female flower surrounded by much-reduced male flowers). Each flower cluster (cyathia) produces a small, erect capsule which measures 2 to 2.5 mm (0.1 in) long and contains three seeds. Seeds are small, spherical, and gray or white (Wagner et al 1999). A different subspecies, *C. celastroides* ssp. *lorifolia,* located

on the south slope of Haleakala, Maui, has been observed reproducing by vegetative means via root suckers. With *C. celastroides* var. *kaenana*, however, vegetative reproduction has not been reported (Sherff 1938; Kimura and Nagata 1980; Koutnik 1987; Koutnik and Huft 1990; U.S. Army Garrison 2003b).

Listing Status *Chamaesyce celastroides* var. *kaenana* was federally and State listed as endangered on October 29, 1991 (56 FR 55770). A recovery plan was prepared for this species in 1995 and 1998 (Service 1995a, 1998a). Critical habitat was designated for *C. celastroides* var. *kaenana* on the island of Oahu on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Chamaesyce celastroides* var. *kaenana* is endemic to the Hawaiian Islands. Historically *C. celastroides* var. *kaenana* occurred in the northwestern portion of the Waianae Mountains as well as the southeastern portion of the Koolau Mountains on the island of Oahu (as indicated from one collection) (Koutnik 1987; Koutnik and Huft 1990; Hawaii Natural Heritage Program 2004). The nine known populations are all located within the vicinity of Kaena Point and Makua Valley on State and Federal lands and contain fewer than 900 individuals (J. Lau, pers.comm. 1990; Hawaii Natural Heritage Program 2004; U.S. Army Garrison 2005c).

About the time of listing this species there were only 300 individuals at five known sites. Today this species appears to be increasing since there are approximately 951 mature plants and 100 immature plants and seedlings in nine occurrences (Service 2006c) (Table SB 6). Thirty-six individuals of this species burned during a prescribed burn the Army conducted in July 22, 2003, (35 within North Kahanahaiki and one plant in the East Kahanahaiki population). The individual impacted by the prescribed burn in East Kahanahaiki appears to be recovering, although not reproducing (L. Durand, pers. comms. 2003, 2004; U.S. Army Garrison 2004a; U.S. Army 2005c). Recent survey data indicates numbers for this species is fairly stable to increasing from population estimates of 545 in 1995 to population estimates over 950 in 2006 (Service 1999b; U.S. Army Garrison 2005c, 2006c). However, particular decreases in populations in Kaluakauila and Waianae may indicate a change in the robust nature of this species. *Chamaesyce celastroides* var. *kaenana* populations are located on Federal, State, city/county, and private lands. Approximately 90 percent of the Oahu *C. celastroides* var. *kaenana* individuals are mature plants with 10 percent populations represented by immature augmentations. Thus, *C. celastroides* var. *kaenana* is characterized by four population units (three of which exceed the 25 mature, reproducing individuals stabilization criteria) on Oahu that represent about 56 percent of all individuals.

Table SB 6. Range-wide Distribution of *Chamaesyce celastroides* var. *kaenana*.

Population Units	**Number of Known Individuals**					
	1991 (1)	**1995** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kaluakauila	--	--	17/1‡	12/7	12/7	6/4
Makua (Lower Ohikilolo)*	--	--	36/4	55/57	89/65	89/65
North Kahanahaiki	--	--	218	177	177	177/0

Puaakanoa	--	--	147/10	145/10	145/10	160/10
East Kahanahaiki	--	--	2	2	2	2/0
Kaena (East of Alau)*	--	--	21/5	21/4	21/24	21/24
Kaena and Keawalua (Kaena)*	--	--	300	300	300	300/0
Kaena and Keawalua (Keawaula)	--	--	69/6	24/1	24/1	56/4
Waianae Kai*	--	--	48	33	33	33/0
Total Individuals on Oahu	**<300**	**545**	**884** (858/26)†	**848** (769/79)	**910** (803/107)	**951** (844/107)

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR 55770)
(2) Recovery plan (Service 1995a)
(3) MIP (MIT 2003), Oahu Biological Opinion (Service 2003a)
(4) MIP Addendum and 2004 status update (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Chamaesyce celastroides* var. *kaenana* typically grows in coastal dry shrubland on windward talus slopes at an elevation of 9 to 640 m (30 to 700 ft) (Hawaii Natural Heritage Program 1990; Koutnik and Huft 1990). *Chamaesyce celastroides* var. *kaenana* is a long-lived perennial that is deciduous in summer. It has been observed flowering and fruiting throughout the year, probably in response to precipitation. Fruits mature in three to four weeks. Little is known about the breeding system of *C. celastroides* var. *kaenana*; however, the genus as a whole is usually monoecious (male and female flowers on different parts of the cyathium) or rarely dioecious (male and female flowers on separate plants). It is not known if the taxon is capable of self-fertilization (U.S. Army Garrison 2003b). Most plants, including the plants in the large colony at Kaena Point, grow on gentle to moderately steep slopes consisting of soil and rock. Others, including many of the plants on the leeward side of the Waianae Mountains, grow on nearly vertical cliff faces. Most sites are now dominated by non-native plants, particularly non-native grasses and *Leucaena leucocephala*. Some sites on the leeward side of the Waianae Mountains still maintain native vegetation. The vegetation on these cliffs is usually sparse, consisting mostly of native shrubs, grasses, and sedges (U.S. Army Garrison 2003b). Other demographic information for *C. celastroides* var. *kaenana* in the wild is unknown.

Threats to the Species *Chamaesyce celastroides* var. *kaenana* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described under "General Status and Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The major threats to *C. celastroides* var. *kaenana* are listed as effects of recreational activities (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004; 68 FR 35950). It is not known if non-native *Chamaesyce* species present in Hawaii could possibly hybridize with the native taxa (Service 1998a; U.S. Army Garrison 2003b). In addition, *C. celastroides* var. *kaenana* is vulnerable to trampling by humans along trails in the Kaena Point Natural Area Reserve and habitat degradation from stochastic events such as landslides, hurricanes, and flooding (68 FR 35950). *Chamaesyce celastroides* var. *kaenana* is vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; Service 1999b). Thus, *C. celastroides* var. *kaenana* has a high background risk of extinction, and any additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Chamaesyce celastroides* var. *kaenana* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations. At least 300 mature, reproducing individuals are needed per population unit to attain stability for long-lived individuals. The recovery plan identifies actions necessary for this species' conservation. Management actions should include fencing, non-native plant control, protection from fire, and outplanting of local genetic material (Service 1998a).

Ongoing Conservation Actions Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Chamaesyce celastroides* var. *kaenana* which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Hawaii Natural Area Reserves System is managing Kaena Point for the recovery of the native vegetation and bird life. The Division of Forestry and Wildlife has restricted off-road vehicle access to the Kaena Point Natural Area Reserve by constructing a large barrier on the Mokuleia side of the reserve. Access from the Waianae side is prevented by a natural washout. Three individuals were outplanted at the Kaena Point Natural Area Reserve in 1995, and, as of July 1997, only one plant survived. Other management activities in the Kaena Point Natural Area Reserve include outplanting and removal of *Leucaena leucocephala* and *Prosopis pallida* in the vicinity of *C. celastroides* var. *kaenana*.

At Makua, the Army Natural Resources Staff have been conducting fuel management, weed control, firebreaks, and genetic storage for this species pursuant to the Makua Implementation Plan Addendum. Propagation material for this species is currently held at the following institutions: Army Environmental Division on Oahu, Harold L. Lyon Arboretum, Lyon Arboretum Seed Storage Facility, National Tropical Botanical Garden, and Waimea Arboretum. The Waianae populations are monitored by the Natural Resources Staff, but are not actively managed due to their location on steep cliffs. In addition, a State-wide strategic plan is being developed by the Hawaii and Pacific Plant Recovery Coordinating Committee that will address the long-term conservation of *Chamaesyce celastroides* var. *kaenana*. This plan will also include broader landscape actions that are needed for the recovery of this species throughout its range (Service 1998a, 2003b; Hawaii and Pacific Plant Recovery Committee 2007). The *ex situ* collections for *C. celastroides* var. *kaenana* include 16 apical or lateral vegetative buds in micropropagation (Harold L. Lyon Arboretum), 58 cuttings in nurseries (Army Environmental Division, Oahu and Harold L. Lyon Arboretum), nine plants in a botanical garden (Waimea Valley Audubon Center), and 5,516 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description A total of 520 ha (1,284 ac) on the island of Oahu has been designated for this species in five separate units. This land was designated to reach the recovery goal of 8 to 10 populations for this species. Critical habitat has been designated on State land (Kaena Point State Park, Kuaokala Forest Reserve, and Waiane Forest Reserve) and private land. Three of the designated units provide habitat for one population each and two units provide habitat for two populations each of 300 mature, reproducing individuals of *Chamaesyce celastroides* var. *kaenana* (68 FR 35950).

The primary constituent elements for these units include windward talus slopes, leeward rocky cliffs, open grassy slopes, or vegetated cliff faces in coastal dry shrubland containing one or more of the following associated native plant species: *Artemisia australis*, *Boerhavia* sp., *Chamaesyce celastroides* var. *amplectens*, *Dodonaea viscosa*, *Gossypium tomentosum*, *Heteropogon contortus*, *Jacquemontia ovalifolia* ssp. *sandwicensis*, *Lipochaeta lobata*, *Myoporum sandwicense*, *Plumbago zeylanica*, *Psilotum nudum*, *Psydrax odorata*, *Santalum freycinetianum*, *Sida fallax*, or *Waltheria indica*. *Chamaesyce celastroides* var. *kaenana* grows at elevations just above sea level to 862 m (0 to 2,827 ft). The plant community, associated species, and elevations are a barometer for such things as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements required for the conservation of this species (68 FR 35950).

<u>Threats to Critical Habitat</u> See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

<u>Status of the Species in the Action Area</u> Of the approximately 950 total range-wide individuals of *Chamaesyce celastroides* var. *kaenana*, roughly 511 (54 percent) are located within the Makua action area. Trends in abundance indicate an overall increase in *C. celastroides* var. *kaenana* individuals in the action area since the 1990s due to augmentation with immature plants and discovery of new mature individuals in the wild. The North Kahanahaiki, East Kahanahaiki, Kalaukauila, and Puaakanoa population units are at risk from training-related wildfire. All of these units (550 individuals) are in the high fire risk zone. Demographic data suggests, 85 percent of the individuals in the action area are mature and 15 percent are immature augmentations.

<u>Status of Critical Habitat in the Action Area</u> The action area contains a total of 30 ha (73 ac), or six percent, of the total critical habitat for *Chamaesyce celastroides* var. *kaenana* island-wide. Designated critical habitat is located within three units that either lie in or overlap the action area. One critical habitat unit is approximately 4 ha (10 ac), and less than one-half ha (1 ac) of this unit is located in the Kaluakauila Management Unit. Another critical habitat unit is (4 ha; 10 ac) located south of the Lower Ohikilolo Management Unit. Both of these units abut the high fire risk zone. A third critical habitat unit is located in the northwestern portion of the Makua action area. This unit totals 231 ha (571 ac). Nine percent (22 ha, 54 ac) of this unit is located within the action area, though none of this unit is located in a management unit. This unit is located in the low fire risk zone and is 1 km (0.6 mi) from the high fire risk zone. About six percent of critical habitat for this subspecies is located in an area at risk from training-related wildfire, with less than one percent of the species' range-wide critical habitat located in the high fire risk zone. The other five percent of the species' range-wide critical habitat located in the action area comprises another two percent of the species' total critical habitat. Approximately 75

percent of the critical habitat that is located in an area has 0 to 25 percent native plant coverage, and 25 percent is in an area with 75 to 100 percent native plant coverage (L. Durand, pers. comm. 2003; U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Chamaesyce celastroides* var. *kaenana* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. This species and its designated critical habitat are both very vulnerable to training related fires due to xeric conditions and proximity to the impact area (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004). The effects of recreational activities and accidental fires are a major threat to *C. celastroides* var. *kaenana*. Several population units have been affected by fire in the last two decades, namely the units of Kaena (East of Alau), Kaena and Keawaula, Lower Ohikilolo, Punapohaku, and possibly Kaluakauila. In addition, in 2003, a prescribed burn that went out of prescription burned several plants in the Kahanahaiki region within Makua. The increasing amount of non-native grasses in the lowlands of the Waianae Range increases the fire threat to this taxon. It is not known if non-native *Chamaesyce* species present in Hawaii could possibly hybridize with the native taxa (Service 1998a; U.S. Army Garrison 2003b).

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Chamaesyce celastroides* var. *kaenana* because fewer than three stable population units exist outside of the Army action area. Four population units have been identified for stabilization. To be considered stable, *C. celastroides* var. *kaenana* must meet the criteria required for stability for a short-lived perennial. The stabilization plan for this taxon includes: habitat and population management of three population units, augmentation of existing populations, collection of full *ex situ* representation of wild stock on Oahu, non-native plant control, and ungulate control. Collection of genetic material will be conducted for all individuals plants located within the boundary of the installation boundary (U.S. Army Garrison 2003b). A post-fire revegetation plan should be developed for the Kaluakauila Management Unit. Research regarding the control of slugs, the black twig borer, and the Chinese rose beetle is important for the protection of all endangered and threatened species habitat because these non-native species pose a significant threat to the health of the native habitat. The approval of aerial dispersal of rodenticide within forest habitat is also needed because rats consume many native seeds and plant parts, which contributes to the degradation and destruction of the native forest (K. Kawelo, pers. comm. 2004). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Kaena to Keawaula, Kaena, Waianae Kai and Makua population units, which contain approximately 60 percent of the total remaining individuals of *Chamaesyce celastroides* var. *kaenana* on Oahu, are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b. Of the 41 ha (102 ac) of critical habitat in the action area, five percent (0.4 ha; 1 ac) is within the Kaluakauila Management Unit. Several ongoing actions being conducted by the Army Natural Resources Staff will benefit both the species and the critical habitat in the Makua action area. Fuel modification is being conducted along the ridgeline between the management unit and the installation boundary to reduce the risk of fire to the site. The Army is conducting fuel modification, habitat restoration, and non-native plant control around the population in Makua at Kaluakauila. Seeds have been collected from some of the populations on Oahu, but additional collection is still necessary. There are 102 plants represented in the seed bank from five population units for *C. celastroides* var. *kaenana*. Seed is currently the best method for genetic storage for this taxon due to its good storage potential (U.S. Army Garrison 2006c). Surveys found additional populations between the Makua and Puaakanaoa Ridge and also within Waianae Kai and Keawaula Management Units (U.S. Army Garrison 2003b; K. Kawelo pers. comm. 2004). Non-native plants and rats are controlled within the vicinity of the Kaluakauila Management Unit. A fence is not needed around the habitat because it is on steep cliffs which ungulates are unable to access.

Status of the Species and Critical Habitat – *Chamaesyce herbstii* (‘Akoko)

Species Description *Chamaesyce herbstii* is a long-lived perennial tree of the Euphorbiaceae (spurge family). It is a small tree 3 to 8 m (9.8 to 26.2 ft) tall with milky sap. The oppositely arranged leaves are 8 to 19.5 cm (3.1 to 7.6 in) long and held in a horizontal plane. The open, branched inflorescences are 7 to 17 cm (2.7 to 6.6 in) long and bear 3 to 15 cyathia (specialized inflorescences with a single central female flower surrounded by much-reduced male flowers). Little is known about the breeding system of *C. herbstii*, but the genus as a whole is usually monoecious (male and female flowers on different parts of a cyathium) or rarely dioecious (male and female flowers on separate plants). The green or green and red seed capsules are 5 to 10 mm (0.2 to 0.4 in) long and contain three seeds, which have a sticky coating when wet (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Chamaesyce herbstii* was federally listed as endangered on October 10, 1996, and was State listed as endangered in Hawaii at the same time (61 FR 53089). A recovery plan for Oahu plants included this species (Service 1998a). Critical habitat was designated for *C. herbstii* on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Chamaesyce herbstii* is a species endemic to the Waianae Mountains of Oahu. Survey data indicate a historically disjunctive range, with the main portion located in the Mokuleia area of the northern Waianae Mountains. This species has never been found south of the Mokuleia area except for a recently extirpated colony in South Ekahanui Gulch (Honouliuli) in the southern Waianae Mountains (Makua Implementation Team 2003). That occurrence was first discovered in the late 1970s, and all 15 trees and several seedlings had died by 2001. Currently, all known remaining individuals of *C. herbstii* occur on State and private lands in gulches of the Kapuna to Pahole population unit in the northern Waianae Mountains (U.S. Army Garrison 2006d; 68 FR 35950).

Trends in abundance indicate that *Chamaesyce herbstii* has undergone a major decline, and currently totals approximately 87 individuals in the Kapuna to Pahole population unit (U.S. Army Garrison 2006d). Current numbers represent a major decline from almost 200 total individuals in 1996 (Table SB 7). This decline likely is due to habitat degradation by non-native ungulates and plants, and low on-site germination (U.S. Army Garrision 2005b). The Kapuna to Pahole population unit contains at least 25 mature, reproducing individuals (the minimum number required for stabilized population for long-lived perennials defined in the Makua Implementation Plan). This population unit also is located within the very low fire risk zone for training-related wildfire. Existing plants produce many flowers and immature seed capsules, but few mature capsules are found on the plants and germination of seedlings in the wild is poor (U.S. Army Garrison 2005b). Thus, available survey data would indicate that *C. herbstii* has been declining in numbers of individuals present in the range, with only one existing population unit with at least 25 mature, reproducing individuals. However, efforts to reverse this decline have been employed through habitat protection and augmentation pursuant the Makua Implentation Plan Addendum (U.S. Army Garrison 2006d, 2005a, Makua Implementation Team 2003)

Table SB 7. Range-wide Distribution of *Chamaesyce herbstii*

Population Units	Number of Known Individuals					
	1996 (1)	**1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kapuna*	--	100	110	52/3[‡]	40/5	49/18 [2/18][§]
Pahole*	--	60	60			
East Makaleha	--	--	--	0	0	0
Central Makaleha	--	10-12	--	0	0	0
West Makaleha*	--		--	0	0	0
Makaha*	--	--	--	0	0	0
South Ekahanui	--	4	0	0	0	0
Total Individuals	**<200**	**<200**	**160**	**55** (52/3)[†]	**45** (40/5)	**87** (49/18) [2/18]

Shaded population units are inside the action area.
* Stabilization population units
[‡]Total mature/immature individuals
[†]Total (mature/immature)
[§][augmented and or reintroduced]

(1) Listing rule (61 FR 53089)
(2) Recovery Plan (Service 1998a)
(3) Critical habitat rule (68 FR 35950), Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2006 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Chamaesyce herbstii* typically grows in gulch bottoms and slopes at elevations between 433 and 928 m (1,420 and 3,044 ft). It usually occurs in mesic forests dominated by a diverse mix of tree species. Little is known about this species' breeding system or whether it is self-compatible. Flowering occurs from August to October, with bees and flies as likely pollinators, and seed capsules are produced from October to January. The sticky seeds are likely dispersed by birds, and probably were dispersed by many now-extinct flightless Hawaiian species. Mature seed capsules split open when dry, flinging the seeds for a short distance (Makua Implementation Team 2003). Longevity of *C. herbstii* plants is 10 to 20 years. Other demographic information for *C. herbstii* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements.

Threats *Chamaesyce herbstii* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. Occurrences of *C. herbstii* are vulnerable to extirpation from habitat degradation by feral ungulates; competition with various non-native plants; wildfire; military activities; and/or reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by erosion, landslides, and rockslides (61 FR 53089; 68 FR 35950; Service 1998a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. herbstii* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *C. herbstii* has a very high background risk of species extinction and any additional threats would eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Chamaesyce herbstii* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). Research is needed on seed storage methods and viability (U.S. Army Garrison 2005b).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Chamaesyce herbstii*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species is located in two management units where it will benefit from population unit and/or ecosystem-level protection. The Pahole Management Unit is fenced; the Upper Kapuna Management Unit is not fenced but is scheduled for fencing within the near future (2007 thru 2009). *Chamaesyce herbstii* plants have been grown from wild-collected seed and successfully outplanted by State biologists since 1995. Seed storage potential has not been tested, and tissue culture techniques for seed have not been successful. Germination rates of wild-collected seed are quite variable (0-100 percent). Seeds that do not germinate within two months generally rot, suggesting the seeds do not form a soil seed bank. Propagation by cuttings has not been successful for this species (U.S. Army Garrison 2005b). In 2005, *C. herbstii* was represented in *ex situ* collections that included two cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), 10 mature fruits in storage at a nursery (Army Environmental Division, Oahu), six ungerminated seeds in a nursery (Harold L. Lyon Arboretum), and 380 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b, U.S. Army Garrison 2005d).

Critical Habitat Description A total of 497 ha (1,227 ac) in three separate units on the island of Oahu was designated for *Chamaesyce herbstii*. Critical habitat was designated on State lands (Mokuleia Forest Reserve and Pahole Natural Area Reserve) and private land (Honouliuli Preserve). Two of the units provide habitat for one population and one unit provides habitat for five populations of 300 mature, reproducing individuals each (68 FR 35950). To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *C. herbstii* (68 FR 35950).

The primary constituent elements of critical habitat include shaded gulch bottoms and slopes in mesic *Acacia koa-Metrosideros polymorpha* lowland forests or diverse mesic forests at elevations between 433 and 928 m (1,420 and 3,044 ft). In addition, all units contain one or more of the following associated native plant species: *Antidesma platyphyllum*, *Coprosma* sp., *Diplazium sandwichianum*, *Hedyotis* sp., *Hibiscus arnottianus* var. *arnottianus*, *Melicope* sp., *Morinda trimera*, *Pipturus albidus*, *Pouteria sandwicensis*, *Pteralyxia* sp., *Urera glabra*, or *Xylosma* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

<u>Threats to the Critical Habitat</u> See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

<u>Status of the Species in the Action Area</u> All known individuals of *Chamaesyce herbstii* are located within the action area, in the Kapuna to Pahole population unit (see Table SB 7). This population unit currently contains 51 mature individuals and meets stabilization requirements according to the numerical criterion; however, threat control and genetic storage goals are not yet complete. Additional immature plants were discovered recently in the Pahole portion of the population unit (U.S. Army Garrison 2005b). The Pahole portion of the population unit is fenced; and the Upper Kapuna portion will be fenced sometime between 2007 and 2009. Plants of this species in the Kapuna to Pahole population unit are located in an area at risk of training-related wildfire. All extant individuals occur in very low fire risk zone. Thus, all remaining known individuals, of *C. herbstii* are found in the action area within one population unit located in an area at very low potential risk of training-related fire. This population unit is characterized by one population unit with at least 25 mature, reproducing individuals.

<u>Status of Critical Habitat in the Action Area</u> The action area contains a total of 204.6 ha (505.5 ac), or 41 percent of the total critical habitat for *Chamaesyce herbstii*. Designated critical habitat is located within one unit in the northeastern portion of the action area. This critical habitat is forty-one percent of a larger 428.6-ha (1,059.2-ac) critical habitat unit that extends outside the action area boundary and provides habitat for five populations of *C. herbstii*. Critical habitat for this species in the action area is at risk of training-related wildfire. Approximately 0.04 ha (0.1 ac) is in the high fire risk zone, 19.7 ha (48.8 ac) are in the low fire risk zone and 184.8 ha (456.6 ac) are in the very low fire risk zone. About 45 percent of the critical habitat in the action area is located in an area with 50 to 75 percent native plant coverage and 30 percent is within an area of 75 to 100 percent native plant coverage (K. Kawelo, pers. comm. 2004; Service 2004b).

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Chamaesyce herbstii* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat"

section, and are tabulated in Appendix E. About 41 percent of critical habitat for this species is located in areas at risk of training-related wildfire. Because all known individuals occur within the action area, *C. herbstii* has a very high background risk of species extinction and any additional threats would eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and the Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Chamaesyce herbstii* because more than 100 percent of all known individuals occur within the action area. Furthermore, because of the low number of individuals, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Three population units have been identified for expedited stabilization of *C. herbstii*: Kapuna to Pahole inside the action area, and Makaha and West Makaleha, outside the action area. The two population units outside the action area will be established through reintroductions after ungulate-exclosure fences are built sometime between 2007 thru 2009. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat Within the Action Area The Kapuna to Pahole population unit, which contains all of the total remaining individuals of *Chamaesyce herbstii*, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). Army Natural Resources Staff and State biologists bag fruits and collect seed for use in augmenting sites in the Pahole portion of the Kapuna to Pahole population unit. The Army also assists with weed control in the Pahole portion. A total of about 272.9 ha (674.3 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Ekahanui, Kahanahaiki, Kaluaa and Waieli, Pahole, Upper Kapuna, West Makaleha). About 173.0 ha (427.5 ac) of the total critical habitat that is within management units is located inside the action area (Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals for this species were three percent complete, with four plants from the one remaining population unit meeting the goals outlined in the Implementation Plan. In addition, there are eight plants growing in the Army greenhouse (U.S. Army Garrison 2005b).

Status of the Critical Habitat – *Colubrina oppositifolia* (Kauila)

Critical Habitat Description A total of 6,400 ha (15,814 ac) in five separate units has been designated for *Colubrina oppositifolia* on three islands. Two units (totaling 4,621 ha; 11,453 ac) were designated on the island of Hawaii, two units (totaling 979 ha; 2,417 ac) were designated on Maui, and one unit (782 ha; 1,935 ac) was designated on Oahu. The units were designated on State (e.g., Kanaio Natural Area Reserve and the Panaewa section of the West Maui Natural Area Reserve on Maui, and Mokuleia Forest Reserve on Oahu) and private lands. One unit on the island of Hawaii and both of the units on Maui provide habitat for one population each. The remaining unit on the islands of Hawaii and the unit on Oahu provides habitat for three populations. Each population is comprised of a minimum of 100 mature, reproducing individuals of *C. oppositifolia* (68 FR 25934; 68 FR 35950; 68 FR 39624).

The primary constituent elements on Oahu include lowland dry or mesic forests dominated by *Diospyros sandwicensis* containing one or more of the following associated native plant species: *Alyxia oliviformis*, *Nestegis sandwicensis*, *Psydrax odorata*, *Reynoldsia sandwicensis*, or *Sapindus oahuensis*. *Colubrina oppositifolia* grows on Oahu at elevations between 255 and 761 m (909 and 2,496 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

<u>Threats to the Species</u> The primary threats to critical habitat for this species on Oahu include habitat destruction by feral pigs and goats, non-native plant species, damage from the black twig borer and Chinese rose beetle, fire, and potential impacts from military activities (68 FR 35950).

Environmental Baseline of the Critical Habitat

<u>Status of the Critical Habitat in the Action Area</u> Less than one percent (21 ha; 51 ac) of the total State-wide critical habitat for *Colubrina oppositifolia* is located within the Makua action area. The critical habitat is located in the northeastern portion of the action area and is in an area of low fire risk. This critical habitat unit, together with 782 ha (1,935 ac) outside the Makua action area, provides habitat for the conservation of three populations, each comprised of a minimum of 100 mature, reproducing individuals of *C. oppositifolia.* It is estimated that 74 percent of the critical habitat is located in an area of no more than 50 percent native plant cover (Service 2001a; K. Kawelo, pers. comm. 2004).

<u>Threats to the Critical Habitat in the Action Area</u> The threats to the primary constituent elements are habitat degradation and predation by feral goats and pigs, damage from the black twig borer and Chinese rose beetle, and potential impacts from military activities. This critical habitat is also threatened by the non-native plant species *Aleurites moluccana*, *Lantana camara*, *Pennisetum setaceum*, *Psidium cattleianum*, *Schinus terebinthifolius*, and *Syzygium cumini,* which compete with associated native plants (K. Kawelo, pers. comm. 2004; 68 FR 35950).

<u>Ongoing Conservation Actions for the Critical Habitat Within the Action Area</u> Of the 21 ha (51 ac) in the action area, 16 ha (39 ac), or 77 percent, is within the Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha Management Units. The Army is controlling ungulates and non-native plant species within the West Makaleha Management Unit. The Upper Kapuna Management Unit will be fenced in the near future (K. Kawelo, pers. comm. 2004).

Status of the Species – *Ctenitis squamigera* (Pauoa)

<u>Species Description</u> *Ctenitis squamigera*, a short-lived member of the woodfern family (Aspleniaceae), has a rhizome creeping above the ground that is densely covered with scales similar to those on the lower part of the leaf stalk. It can be readily distinguished from other Hawaiian species of *Ctenitis* by the dense covering of tan-colored scales on its frond (Service 1998b).

Listing Status *Ctenitis squamigera* was federally listed as endangered on September 26, 1994 (59 FR 49025), and was State listed as endangered at the same time. A recovery plan for four species of Hawaiian ferns was completed in 1998 (Service 1998b). Critical habitat was designated for *C. squamigera* on February 27, 2003, on the islands of Kauai and Niihau (68 FR 9115), May 14, 2003, on the islands of Maui and Kahoolawe (68 FR 25934), and June 17, 2003, on the island of Oahu (68 FR 35950).

Historic and Current Distribution Historically, *Ctenitis squamigera* was recorded from Kauai, the Koolau and Waianae Mountains of Oahu, Lanai, Molokai, Maui, and the island of Hawaii. This species is currently extant on Oahu, Molokai, Lanai, and Maui. Currently on Oahu, eight occurrences with more than 80 individuals are located in Makaleha Valley, Kaawa Gulch, Makua Valley, and Waianae Kai Forest Reserve on Federal, State, and private lands (68 FR 35950). There is one population on Oahu with more than 50 mature, reproducing individuals (the minimum number suggested for stabilization populations for this species) and there are two populations off-island with more than 50 mature, reproducing individuals.

Table SB 8. Range-wide Distribution of *Ctenitis squamigera*.

Population Units	**Number of Known Individuals**							
	1994 (1)	**1998 & 1999** (2)	**2003** (3)	**2003** (4)	**2003** (5)	**2003** (6)	**2005** (7)	**2006** (8)
Makua	--	--	--	--	--	--	3	2
Palikea Gulch	--	--	--	--	--	--	3	--
East Makaleha	--	--	--	--	--	--	100+	80/2‡
Waianae Kai	--	--	--	--	--	--	1	--
West Makaleha	--	--	--	--	--	--	1	1
Kaawa Gulch	--	--	--	--	--	--	--	--
Total Population Units on Oahu	7	4	8	--	--	--	5	3
Total Individuals on Oahu	--	--	**80**	--	--	--	**≥100**	**106** (85/21)†
Total Population Units State-wide	14	10	--	12*	1§	2¶	17	--
Total Individuals State-wide	**~80**	**~100**	--	**41***	**20§**	**42¶**	**~350**	--

Shaded population units are inside the action area.
‡Total mature/immature individuals
†Total (mature/immature)
*Surveys available from island of Maui only
§Surveys available from island of Molokai only
¶Surveys available from island of Lanai only

(1) Listing rule (59 FR 49025)
(2) Recovery plan (Service 1998b); Makua Endangered Species Mitigation Plan (Service 1999b)
(3) Critical habitat rule (68 FR 35950)
(4) Critical habitat rule (68 FR 25934)
(5) Critical habitat rule (68 FR 12982)
(6) Critical habitat rule (68 FR 1220)
(7) Army re-initiation request (U.S. Army Garrison 2005c)
(8) Army database (U.S. Army Garrison 2006d)

Ecology *Ctenitis squamigera* is found on gentle to steep slopes in *Metrosideros polymorpha-Diospyros sandwicensis* mesic forest and diverse mesic forest at elevations of 387 to 923 m (1,269 to 3,027 ft). Associated native plant taxa include *Alyxia oliviformis, Carex meyenii, Diospyros hillebrandii, Dodonaea viscosa, Doodia kunthiana, Dryopteris unidentata, Freycinetia arborea, Hibiscus* sp., *Myrsine* sp., *Nestegis sandwicensis, Pisonia* sp., *Pouteria sandwicensis, Psychotria* sp., *Psydrax odorata*, or *Xylosma* sp. (68 FR 35950). Reproductive cycles, longevity, specific environmental requirements and limiting factors are unknown (Service 1998b).

Threats to the Species *Ctenitis squamigera* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Human disturbance from hikers, vehicles, etc. is believed to pose a significant threat to this species. Habitat degradation caused by axis deer is now considered a major threat to the forests of Lanai and all three of the Lanai populations/occurrences of *C. squamigera* are negatively affected to some extent by axis deer (Service 1999b).
Ctenitis squamigera is currently extant on Oahu, Molokai, Lanai, and Maui. With only three populations harboring more than 50 mature, reproducing individuals, located on two islands, this species has a high risk of background extinction. Protection from existing threats as well as future threats is needed to ensure the survival of this species.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Ctenitis squamigera* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *C. squamigera* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua or Schofield Barracks action areas (Service 2003a).

Ongoing Conservation Actions No information is available on conservation management for *Ctenitis squamigera* since it was listed as endangered. However, about five individuals (one percent of all remaining individuals) of this species occur in two management units where they will benefit from population unit and/or ecosystem-level protection. The management units include West Makaleha and Ohikilolo which are fenced. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any *C. squamigera* within the preserve.

Environmental Baseline of the Species

Status of the Species in the Action Area There is one occurrence of *Ctenitis squamigera* in the action area with fewer than five individuals, or about one percent of the species' range-wide distribution (U.S. Army Garrison 2005c) (see Table SB 8). All known *C. squamigera* within the action area are within fenced ungulate exclosures. All individuals of *C. squamigera* in the action area are located in areas of low risk from training-related wildfire.

Threats to the Species and in the Action Area The primary threats to *Ctenitis squamigera* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. There is no critical habitat for *Ctenitis squamigera* in the action area, so no threats to critical habitat exist in the action area.

Conservation Needs of the Species in the Action Area Three individuals of *Ctenitis squamigera* occur within the action area in Makua Valley, representing one percent of the total number of individuals State-wide (U.S. Army Garrison 2005c). Therefore, *Ctenitis squamigera* does not require stabilization by the Army. Other general conservation needs of the species in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area No conservation actions are currently being implemented for *Ctenitis squamigera* in the action area. However, this species benefits from ecosystem-level management in the fenced West Makaleha and Ohikilolo Management Units, where non-native ungulates and weeds are controlled. This species is represented in an *ex situ* collection of 30 ungerminated spores in micropropagation (Harold L. Lyon Arboretum) (Service 2005b).

Status of the Species and Critical Habitat – *Cyanea grimesiana* ssp. *obatae* (Haha)

Species Description *Cyanea grimesiana* ssp. *obatae* is a short-lived perennial in the Campanulaceae (bellflower family). It is a single-stemmed or sparingly branched shrub 1 to 3.2 m (3.3 to 10.5 ft) tall, with leaves clustered at the stem tips. The wide, deeply lobed, pinnate leaves are 27 to 58 cm (10.6 to 22.8 in) long and 14 to 32-cm (5.5 to 12.6 in) wide. The tubular flowers are purple or green to yellow-white and 5.5 to 8.0-cm (2.2 to 3.1 in) long. The elliptical orange berries are 1.8 to 3.0-cm (0.7 to 1.2 in) long. *Cyanea grimesiana* ssp. *obatae* can be distinguished from the two other subspecies of *C. grimesiana* by its short, narrow calyx lobes that are not fused and do not overlap (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status   *Cyanea grimesiana* ssp. *obatae* was federally listed as endangered on June 27, 1994 (59 FR 32932), and was State listed as endangered at the same time. This subspecies was included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat was designated for *C. grimesiana* ssp. *obatae* on June 17, 2003 (68 FR 35950).

The genus *Cyanea* is one of the largest Hawaiian plant genera and incorporates a high proportion of rare taxa, including 28 endangered taxa, 1 threatened taxon, 8 candidates for listing, and 17 species of concern (Service 2006a, Hawaii Biodiversity and Mapping Program 2006).

Historic and Current Distribution   *Cyanea grimesiana* ssp. *obatae* is a species endemic to Oahu. Survey data indicate *C. grimesiana* ssp. *obatae* historically was known from an area extending for about 6.5 km (4 mi) in the southern Waianae Mountains (59 FR 32932). Many of the occurrences that have been monitored over the last 15 to 20 years have either died out or have greatly declined in numbers; most of the known occurrences have been recently discovered. Survey data has only been consistent since 2003. At the time of listing in 1994, there were approximately 18 known individuals in three occurrences (59 FR 32932). Currently, there are 254 total individuals in six population units, located on State and private lands (Table SB 9) (U.S. Army Garrison 2005b; 68 FR 35950). None of the currently known population units of this subspecies contain 100 mature, reproducing individuals (the minimum number required for stabilized population as defined in the Makua Implementation Plan). One naturally occurring plant was recently discovered at Makaha, which represents a new occurrence for this subspecies. A new, naturally occurring plant was also recently discovered in the Central Kaluaa population unit. The subspecies identity of the one immature plant in the Palikea Gulch population unit has not been confirmed as it has not yet flowered (U.S. Army Garrison 2005b). The Pahole to West Makaleha population unit is located within very low fire risk zone for training-related wildfire.

Demographic data for this species indicate that about 76 percent of all currently existing individuals of *Cyanea grimesiana* ssp. *obatae* are augmentations or reintroductions from greenhouse-propagated stock. Augmentations have been outplanted at five separate locations, including all three stabilization population units; four locations are on land owned by The Nature Conservancy of Hawaii and one location is on State land. This subspecies is easy to propagate and outplant. Plants produce ample viable seed but the genetic base is limited owing to the low number of founder individuals. Recruitment is limited by rats and slugs, which attack plants of all size classes. Survival of some outplanted individuals is relatively good (about 70 percent in the Central Kaluaa population unit, for example); at other locations, however, slug predation limits survival and recruitment (U.S. Army Garrison 2005b). Natural regeneration has been observed only at the West Makaleha and Palikea (South Palawai) population units; these sites are also the only naturally occurring sites with more than one mature plant. The Palikea (South Palawai) population unit contains the largest number of naturally occurring plants, all age classes are vigorous, and recent regeneration in this population unit has been good (U.S. Army Garrison 2005b). Thus, *C. grimesiana* ssp. *obatae* is characterized by six population units containing fewer than 100 mature, reproducing plants with three units that contain only one individual, and low numbers that are increasing primarily due to augmentation.

Table SB 9. Range-wide Distribution of *Cyanea grimesiana* ssp. *obatae*

Population Units	Numbers of Known Individuals					
	1994 (1)	**1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Pahole*	--	--	6	7/3‡ [14/19]§	8/2 [15/15]	7/9 [24/2]
West Makaleha*	--	--	7			
Central Kaluaa*	--	--	--	1/0	1/0 [0/70]	1/0 [26/40]
Makaha	--	--	--	0	1/0	1/0
North Branch of South Ekahanui	--	--	5	0	0/0 [4/6]	0/0 [21/18]
Palikea Gulch	--	--	1	0/1	0/1	0/1
Palikea (South Palawai)*	--	--	28	8/7	10/30 [0/12]	10/32 [44/18]
South Kaluaa	--	--	2	1/0	1/0 [0/14]	0/0
Total Individuals	**18**	**13**	**49**	**61** (17/11)† [14/19]	**190** (21/33) [19/117]	**254** (19/42) [115/78]

Shaded population units are inside the action area.
* Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (59 FR 32932)
(2) Recovery Plan (Service 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Cyanea grimesiana* ssp. *obatae* typically grows on steep, moist, shaded slopes in diverse mesic to wet lowland forests at elevations between 404 and 1,075 m (1,325 and 3,528 ft). It often grows on steep, vertical embankments in rock or a mix of rock and soil. This subspecies may produce flowers and fruits year round, depending on rainfall. The long tubular flowers and orange berries of this taxon suggest pollination and seed dispersal by birds may be common; however, the plants are capable of self-pollination and isolated plants have been found with viable seeds. *Cyanea grimesiana* ssp. *obatae* presumably lives less than 10 years like other *Cyanea* of similar size (Makua Implementation Team 2003). Other demographic information for *C. grimesiana* ssp. *obatae* in the wild is unknown, including longevity, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats *Cyanea grimesiana* ssp. *obatae* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. This subspecies is particularly vulnerable to predation by rats and slugs. Major rat damage has occurred to five mature plants in West Makaleha population unit, and slugs prey on plants of all size/age classes. Slugs likely attack all members of this genus, as suggested by investigations of the related *Cyanea superba* ssp. *superba*. Slug predation killed half of 14 outplants at the North Branch of South Ekahanui population unit, and the remaining plants are in poor condition most likely due to the stress of predation (U.S. Army Garrison 2005b).

Occurrences of *Cyanea grimesiana* ssp. *obatae* are vulnerable to extirpation from habitat degradation by feral ungulates; competition with various non-native plants; wildfire; military activities; and/or reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by rat or slug predation, erosion, landslides, and rockslides (59 FR 32932; 68 FR 35950; Service 1995a, 1998). This subspecies tends to fluctuate widely in population size and has a recent history of decline; any catastrophic disturbance during a major low point could extirpate one or more population units or result in subspecies extinction in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. grimesiana* ssp. *obatae* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. In addition, the long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *C. grimesiana* ssp. *obata* have been almost totally extirpated from the Waianae Mountains. Although this subspecies is capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003). Low genetic variability and small population size usually result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for long-term persistence of the subspecies. Thus, *C. grimesiana* ssp. *obatae* has a very high background risk of subspecies extinction and any additional threats could eliminate expectation of its long-term persistence.

<u>Conservation Needs of the Species</u> Conservation actions that should be implemented for the recovery of *Cyanea grimesiana* ssp. *obatae* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this subspecies specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). A stabilization target of at least 100 mature, reproducing individuals is needed per population unit to attain stability for this short-lived perennial because large fluctuations in numbers and a recent history of decline (Makua Implementation Team 2003). The fence at the Palikea (South Palawai) population unit needs to be expanded to increase the area for future outplantings. The Makaha plant is not within the management subunit that will be fenced in 2007; it is scheduled for fencing in 2009. The number of *C. grimesiana* ssp. *obatae* founders represented at reintroduction sites needs to be increased and equalized. Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *C. grimesiana* ssp. *obatae* and associated native plants.

<u>Ongoing Conservation Actions</u> The Makua Implementation Team (2003) has developed stabilization protocols for *Cyanea grimesiana* ssp. *obatae*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). All population units (except Makaha) are protected by fenced exclosures. Reintroductions within the North Branch of South Ekahanui population unit are within the management unit fence, although the naturally occuring

site (now extirpated) is not. The Army and the State have been augmenting occurrences in the Pahole to West Makaleha population unit, and The Nature Conservancy of Hawaii has been augmenting occurrences in the Palikea (South Palawai) population unit. Rat control grids (toxicant bait stations and snap traps) are maintained during the *C. grimesiana* ssp. *obatae* fruiting season at all population units except Pahole and Palikea Gulch. This subspecies is located in occurrences over four management units where it will also benefit from population unit and/or ecosystem-level protection: Pahole, West Makaleha, Kaluaa and Waieli, and Palikea.

Cyanea grimesiana ssp. *obatae* can be successfully propagated from seed, although the seedlings grow very slowly. Germination rates vary between seed collected from the same plant and among different plants. Seed can generally be collected throughout the year owing to variation among the population units in flower morphology and fruiting season. Plants in some population units are reproductive almost year-round, while others flower seasonally in summer, fall, or winter. This subspecies usually is grown in the greenhouse until plants are large enough to survive outplanting, as larger plants may be more tolerant of slug predation. The Army recently assisted The Nature Conservancy in an "aggressive" outplanting that involved reintroduction of relatively small plants at the Central Kaluaa population unit (U.S. Army Garrison 2005b). Smaller plants require a shorter growing time in the nursery, are easier to transport, and can be planted in more locations such as steep slopes where wild plants are known to occur. However, the mortality of these small outplants was greater than that of larger outplants. This aggressive approach of outplanting smaller individuals may be justified for this subspecies because of the large amount of seed available (U.S. Army Garrison 2005b). In addition, this subspecies is represented in several *ex situ* collections, which in 2005 included 11 cuttings in a nursery (Harold L. Lyon Arboretum), 51 mature fruit in storage or awaiting processing at a nursery (Army Environmental Division, Oahu), 4,465 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 215,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 642 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

<u>Critical Habitat Description</u> A total of 824 ha (2,035 ac) in four separate units on the island of Oahu was designated for *Cyanea grimesiana* spp. *obatae*. Critical habitat was designated on Federal land (Lualualei Naval Reservation), State lands (Mokuleia Forest Reserve and Pahole Natural Area Reserve), and private land (Honouliuli Preserve). Three of the critical habitat units provide habitat for one population each and one unit provides habitat for three populations of 300 mature, reproducing individuals. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *C. grimesiana* spp. *obatae* (68 FR 35950).

The primary constituent elements of critical habitat include steep, moist, shaded slopes in diverse mesic to wet lowland forests at elevations between 404 and 1,092 m (1,325 and 3,528 ft). In addition, all units contain one or more of the following associated native plant species: *Acacia koa*, *Antidesma platyphyllum*, *Chamaesyce* sp., *Charpentiera obovata*, *Cibotium chamissoi*, *Claoxylon sandwicense*, *Coprosma* sp., *Cyanea membranacea*, *Cyrtandra waianaeensis*, *Diplazium sandwichianum*, *Dryopteris unidentata*, *Dubautia* sp., *Freycinetia arborea*, *Hedyotis acuminata*, *H. terminalis*, *Metrosideros polymorpha*, *Myrsine lessertiana*, *Nothocestrum* sp., *Perrottetia sandwicensis*, *Pipturus albidus*, *Pisonia umbellifera*, *Pouteria sandwicensis*, *Psychotria hathewayi*, *Rumex* sp., *Selaginella arbuscula*, or *Streblus pendulinus*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are primary constituent elements of the habitat required for the subspecies' conservation.

Threats to the Critical Habitat See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 16 percent of all known individuals of *Cyanea grimesiana* spp. *obatae* are located within the action area, in the Pahole to West Makaleha population unit (see Table SB 9). Of the 42 total individuals in this population unit, 62 percent are augmented individuals. This population unit currently contains 31 mature individuals, of which 24 are augmented individuals. The Army assisted the State with reintroducing 45 plants of Pahole stock into the Pahole portion of the population unit in 2003; as of August 2005, about 65 percent had survived and were healthy. No regeneration has yet occurred at the Pahole reintroduction site. In the West Makaleha portion of the population unit, an ungulate exclosure and a rat control grid are in place around *C. grimesiana* spp. *obatae* plants. Because of serious rat damage to the five mature plants in West Makaleha, the Army has increased the number of bait stations and monitored them more frequently; no further rat damage has been observed (U.S. Army Garrison 2005b). *Cyanea grimesiana* spp. *obatae* plants in the Pahole to West Makaleha population unit (42 individuals) are located in an area at very low fire risk zone for training-related wildfire. These individuals at risk of fire in the action area represent about 16 percent of the subspecies' total range-wide numbers. Thus, *C. grimesiana* spp. *obatae* in the action area is characterized by two population units not reaching numerical criteria for stabilization (100 mature, reproducing individuals) that comprises 16 percent of all remaining individuals, with low numbers that are maintained primarily by augmentation, and at very low risk of training-related wildfire.

Status of Critical Habitat in the Action Area The action area contains a total of 208.5 ha (512.2 ac), or 25 percent of the total critical habitat for *Cyanea grimesiana* ssp. *obatae*. Designated critical habitat is located within one unit in the northeastern portion of the action area. This critical habitat is a portion of a larger 522.3-ha (1,290.6-ac) critical habitat unit that extends outside the action area boundary and provides habitat for three populations of *C. grimesiana* ssp. *obatae*. Critical habitat for this species in the action area is at risk of training-related wildfire, with 0.1 ha (0.3 ac) located in the high fire risk zone, 15.7 ha (38.7 ac) in the low fire risk zone, and 192.7 ha (476.2 ac) in the very low fire risk zone. More than 50 percent of the critical habitat is in an area with 50 to 100 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Cyanea grimesiana* ssp. *obatae* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Cyanea grimesiana* ssp. *obatae* in the action area is particularly vulnerable to predation by rats and slugs. About 25 percent of critical habitat for this subspecies is located in an area at high, low, and very low risks of training-related wildfire. Thus, because about 16 percent of all known individuals occur within the action area, *C.*

grimesiana ssp. *obatae* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Cyanea grimesiana* ssp. *obatae* because no population units meeting minimum numerical criteria for stabilization exist outside the action area. Furthermore, because of its low numbers, this subspecies is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Three population units have been identified for expedited stabilization of *C. grimesiana* ssp. *obatae*: Pahole to West Makaleha within the action area, and Central Kaluaa and Palikea (South Palawai) outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *C. grimesiana* ssp. *obatae* and associated native plants. Other general conservation needs of the subspecies and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Pahole to West Makaleha population unit, which contains 16 percent of the total remaining individuals of *Cyanea grimesiana* ssp. *obatae*, is being managed for stabilization as specified by the Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located within the Pahole and West Makaleha Management Units. The Pahole Management Unit is fenced and a small exclosure in the West Makaleha Management Unit protects *C. grimesiana* ssp. *obatae* plants there. A total of about 332.2 ha (820.6 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Ekahanui, Kaluaa and Waieli, Pahole, Palikea, Upper Kapuna, West Makaleha). About 180.5 ha (446.1 ac) of the total critical habitat that is within management units is located inside the action area (Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were about eight percent complete, with 23 plants from five population units combined (including the Pahole to West Makaleha population unit) meeting the goals outlined in the Makua Implementation Plan. In addition, there were 15 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Cyanea longiflora* (Haha)

Species Description *Cyanea longiflora* is a short-lived perennial in the Campanulaceae (bellflower family). It is a single-stemmed or sparingly branched shrub 1 to 3 m (3.3 to 9.8 ft) tall. The leaves are 30 to 55 cm (11.7 to 21.5 in) long and clustered at the stem tips. The tubular, dark magenta flowers are 6 to 9 cm (2.3 to 3.5 in) long. The pear-shaped orange berries are 10 to 12 mm (3.9 to 4.7 in) long (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Cyanea longiflora* was federally listed as endangered on October 10, 1996 (61 FR 53089), and was State listed as endangered at the same time. This species was included in the recovery plan for Oahu plants (Service 1998a). Critical habitat was designated for *C. longiflora* on June 17, 2003 (68 FR 35950).

The genus *Cyanea* is one of the largest Hawaiian plant genera and incorporates a high proportion of rare taxa, including 28 endangered taxa, one threatened taxon, eight candidates for listing, and 17 species of concern (Service 2006a, Hawaii Biodiversity and Mapping Program 2006).

Historic and Current Distribution *Cyanea longiflora* is a species endemic to Oahu. Survey data indicate *C. longiflora* historically was known from five occurrences in the Waianae Mountains and six occurrences in the Koolau Mountains. Currently, only the Waianae occurrences are extant, however, they have declined in numbers of known individuals since the listing. Survey data has only been consistent since 2003. At the time of listing in 1996, there were over 200 individuals in five occurrences (61 FR 53089). Currently, there are 171 total individuals in three population units, located on State and city/county lands (Table SB 10) (U.S. Army Garrison 2006d; 68 FR 35950). None of the currently known population units of this subspecies contain 75 mature, reproducing individuals (the minimum number required for stabilized population defined in the Makua Implementation Plan). In general, known population units are located in manageable areas where threats can be controlled. The Kapuna to West Makaleha population unit is located within low and very low fire risk zones for training-related wildfire, and the Makaha to Waianae Kai population unit is at risk of fire from illegal campfires (U.S. Army Garrison 2005b).

Demographic data for this species indicate that about 47 percent of all currently existing individuals of *Cyanea longiflora* are mature plants. Recruitment probably is limited by slugs, which attack plants of all size classes in this genus. Thus, *C. longiflora* is characterized by three population units that are not meeting minimum numeric stabilization criteria (75 mature, reproducing individuals) and that have decreased in individuals overall since listing with two occurrences that are increasing in numbers primarily due to augmentation and habitat protection.

Table SB 10. Range-wide Distribution of *Cyanea longiflora*

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Numbers of Known Individuals</th></tr>
<tr><th>1996
(1)</th><th>1998
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kapuna*</td><td>--</td><td>--</td><td rowspan="2">63</td><td rowspan="3">40/0‡</td><td rowspan="3">23/6
[0/21]§</td><td rowspan="3">28/8
[0/20]</td></tr>
<tr><td>Keawapilau*</td><td>--</td><td>--</td></tr>
<tr><td>West Makaleha*</td><td>--</td><td>--</td><td>3</td></tr>
<tr><td>Pahole*</td><td>--</td><td>--</td><td>114</td><td>50/0</td><td>30/65</td><td>49/53</td></tr>
<tr><td>Makaha and Waianae Kai*</td><td>--</td><td>--</td><td>7</td><td>4/8</td><td>3/10</td><td>3/10</td></tr>
<tr><td>Total Individuals</td><td>220-300</td><td>200-220</td><td>187</td><td>102
(94/8)†</td><td>158
(56/81)
[0/21]</td><td>171
(80/71)
[0/20]</td></tr>
</table>

Shaded population units are inside the action area.
* Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (61 FR 53089)
(2) Recovery Plan (Service 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)

(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Cyanea longiflora* usually grows below ridge crests and on upper gulch slopes in mesic *Acacia koa-Metrosideros polymorpha* forests at elevations between 146 and 1,191 m (479 and 3,906 ft). The long tubular flowers and orange berries of this taxon suggest pollination and seed dispersal by birds may be common. As with other *Cyanea* species with long tubular flowers, *C. longiflora* likely was pollinated by nectar-feeding birds. However, it is capable of self-pollination, as evidenced by the fact that isolated plants produce viable seeds. *Cyanea longiflora* presumably lives less than 10 years like other *Cyanea* of similar size (Makua Implementation Team 2003). Other demographic information for *C. longiflora* in the wild is unknown, including longevity, flowering and fruiting phenology, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats *Cyanea longiflora* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section, and are tabulated in Appendix E. This species is particularly vulnerable to slug predation. Slugs likely attack all members of this genus, as suggested by investigations of the related *Cyanea superba* ssp. *superba* (U.S. Army Garrison 2005b). This species is not fire resistant; an illegal campfire that escaped in the Makaha and Waianae Kai population unit killed one of the three existing mature *C. longiflora* plants within that unit (U.S. Army Garrison 2005b).

Occurrences of *Cyanea longiflora* are vulnerable to extirpation from habitat degradation by feral ungulates; competition with various non-native plants; wildfire; military activities; and/or reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by rat or slug predation, erosion, landslides, and rockslides (61 FR 53089; 68 FR 35950; Service 1998a). This species tends to fluctuate widely in population size and has a history of local decline; any catastrophic disturbance during a major low point could extirpate one or more population units or result in species extinction in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. longiflora* already is in a phase of “quasi-extinction” with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. In addition, the long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *C. longiflora* have been almost totally extirpated from the Waianae Mountains. Although this species is capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003). Low genetic variability and small population size usually result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for long-term persistence of the species. Thus, *C. longiflora* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species   Conservation actions that should be implemented for the recovery of *Cyanea longiflora* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). A stabilization target of at least 75 mature, reproducing individuals is needed per population unit to attain stability for this short-lived perennial because large fluctuations in numbers and a recent history of decline (Makua Implementation Team 2003). In particular, research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *C. longiflora* and associated native plants.

Ongoing Conservation Actions   The Makua Implementation Team (2003) has developed stabilization protocols for *Cyanea longiflora*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species is located in occurrences over four management units where it will benefit from population unit and/or ecosystem-level protection: Pahole, Upper Kapuna, West Makaleha, and Makaha and Waianae Kai.

Cyanea longiflora can be successfully propagated from seed. Seed viability varies among plants (80 to 100 percent) and germination rates for some plants are low (20 to 40 percent). Larger plants survive better when outplanted in the wild than small plants (U.S. Army Garrison 2005b). In 2005, this species was represented in *ex situ* collections that included two cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), 209 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 79,173 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 90 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description   A total of 431 ha (1,064 ac) in three separate units have been designated for this species. Critical habitat has been designated on State lands (Mokuleia, Waianae Kai, and Pupukea-Paumalu Forest Reserves, and Pahole Kaala Natural Area Reserve) and private land. One of the critical habitat units provides habitat for four populations of 300 mature, reproducing individuals each, one unit provides habitat for three populations, and one unit provides habitat for one population. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *C. longiflora* (68 FR 35950).

The primary constituent elements of critical habitat include steep slopes, bases of cliffs, or ridge crests in mesic *Acacia koa-Metrosideros polymorpha* lowland forest at elevations between 146 and 1,191 m (479 and 3,906 ft). In addition, all units contain one or more of the following associated native plant species: *Antidesma* sp., *Cibotium* sp., *Coprosma* sp., *Dicranopteris linearis*, *Psychotria* sp., *Schiedea* sp., or *Syzygium sandwicensis*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat   See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area   About 87 percent of all known individuals of *Cyanea longiflora* are located within the action area, in the Kapuna to West Makaleha and Pahole population units (see Table SB 10). Additional mature and immature individuals were observed in known action area sites in 2006 (U.S. Army Garrison 2006d). The Pahole population unit appears healthy, with naturally occurring plants of all size/age classes, and the number of mature individuals in this population unit has increased since 2003. This population unit is fenced to exclude ungulates and dominated by native vegetation (U.S. Army Garrison 2005b).

Cyanea longiflora plants in the two population units are located in areas of low and very low fire risk zones for training-related wildfire. About 56 individuals occur in the low fire risk zone and 102 individuals are in the very low fire risk zone, and together represent about 87 percent of the species' total range-wide known individuals. Thus, *C. longiflora* in the action area is characterized by two population units not yet achieving numerical criteria for stabilization that comprise 87 percent of all remaining individuals and located in zones at low and very low risks of training-related wildfire.

Status of Critical Habitat in the Action Area   The action area contains a total of 177.0 ha (437.4 ac), or 24 percent of the total critical habitat for *Cyanea longiflora*. Designated critical habitat is located within one unit in the northeastern portion of the action area. This critical habitat is a portion of a larger 362.4-ha (895.5-ac) critical habitat unit that extends outside the action area boundary and provides habitat for four populations of *C. longiflora*. Critical habitat for this species in the action area is at risk of training-related wildfire, with 9.2 ha (22.6 ac) located in the low fire risk zone and 167.9 ha (414.8 ac) in the very low fire risk zone. About 49 percent of critical habitat in the action area is located in an area with 50 to 75 percent native plant coverage, and 35 percent is in an area with 75 to 100 percent native plant coverage (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area   The primary threats to *Cyanea longiflora* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Cyanea longiflora* in the action area is particularly vulnerable to slug predation. None of the naturally occurring plants in the Kapuna to West Makaleha population unit are within fences and are at risk of habitat degradation by feral pigs and ungulates. About 24 percent of the entire critical habitat for this species is located in an area at low or very low risks of training-related wildfire. Thus, because about 87 percent of all known individuals occur within the action area, *C. longiflora* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area   The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Cyanea longiflora* because more than half of all remaining individuals are located within the action area and no population units meeting minimum numerical criteria for stabilization exist outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. All three existing population units have been identified for expedited stabilization of *C. longiflora*:

Kapuna to West Makaleha, and Pahole within the action area, and Makaha and Waianae Kai outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *C. longiflora* and associated native plants. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area</u> The Kapuna to West Makaleha, and Pahole population units, which contain 87 percent of the total remaining individuals of *Cyanea longiflora*, are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located within the Pahole, Upper Kapuna, and West Makaleha Management Units. The Pahole Management Unit is fenced, and reintroduced plants in the West Makaleha portion of the Kapuna to West Makaleha population unit are within a small exclosure (naturally occurring individuals in this population unit are on steep cliffs inaccessible to pigs). A total of about 196.5 ha (485.5 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Manuwai, Pahole, Upper Kapuna, West Makaleha). About 153.0 ha (378.1 ac) of the total critical habitat that is within management units is located inside the action area (Pahole, Upper Kapuna, West Makaleha). In 2005, genetic storage goals were about 21 percent complete, with 31 plants from the three existing population units combined meeting the goals outlined in the Makua Implementation Plan. In addition, there were five plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Cyanea superba* ssp. *superba* (Haha)

<u>Species Description</u> *Cyanea superba* ssp. *superba* is a long-lived perennial in the Campanulaceae (bellflower family). It is a tree 4 to 6 m (13 to 20 ft) tall with a single major stem, or occasionally two or more major stems arising from the base of the plant. The leaves are 0.5 to 1.0 m (1.6 to 3.3 ft) long and clustered at the stem tips. The curved, tubular, white or cream-colored flowers are 5.5 to 8.8 cm (2.1 to 3.4 in) long. The egg-shaped yellow or orange berries are 16 to 22 mm (0.6 to 0.9 in) long (Wagner et al 1999; Makua Implementation Team 2003).

<u>Listing Status</u> The species *Cyanea superba* was federally listed as endangered on September 11, 1991 (56 FR 46235), and was State listed as endangered at the same time. The species was included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat was designated for *C. superba* on June 17, 2003 (68 FR 35950). *Cyanea superba* is comprised of two subspecies, *C. superba* ssp. *superba* of the northern Waianae Mountains and *C. superba* ssp. *regina* of the southeastern Koolau Mountains. Both subspecies are contained within the listed taxon, but *Cyanea superba ssp. regina* has not been observed since 1960 (Makua Implementation Team 2003).

The genus *Cyanea* is one of the largest Hawaiian plant genera and incorporates a high proportion of rare taxa, including 28 endangered taxa, one threatened taxon, eight candidates for listing, and 17 species of concern (Service 2006a, Hawaii Biodiversity and Mapping Program 2006).

<u>Historic and Current Distribution</u> *Cyanea superba* ssp. *superba* is a subspecies endemic to Oahu. Survey data indicate *C. superba* ssp. *superba* historically was first collected in 1870 from eastern Mt. Kaala and Makaleha Valley in the northern Waianae Mountains. No further observations were recorded until it was rediscovered in 1971. At the time of listing, there were fewer than 20 individuals in two occurrences, Pahole and Kahanahaiki (56 FR 46235). By 2002, all naturally occurring plants had died. All currently existing plants in the wild are reintroductions from greenhouse-propagated stock, which the Army has been outplanting since 1999 and the State since the mid 1990s (U.S. Army Garrison 2005b). Trends in abundance and distribution indicate there are currently 311 total individuals in two population units located on Federal and State lands (Table SB 11) (U.S. Army Garrison 2006d). Both of these population units are exceeding minimum numeric criteria for stablization (defined as 50 mature, reproducing individuals per population unit). The Kahanahaiki and Pahole to Kapuna population units are located within the low and very low fire risk zones for training-related wildfire (U.S. Army Garrison 2005b). The Central and East Makaleha, and Makaha, population units are designated as future reintroduction sites for this subspecies.

Demographic data for this species indicate that survival and recruitment of *Cyanea superba* ssp. *superba* are limited by slugs, which attack plants of all size/age classes in this genus. About 55 percent of total individuals are mature plants. Most reintroductions have involved progeny from a single Kahanahaiki founder plant. Although studies have demonstrated extremely low genetic variability in this subspecies, inbreeding depression apparently is not significant as plants grow vigorously, flower, and produce viable seed. Nonetheless, there is no evidence of recruitment in the wild, due to very high slug predation on small size classes and rat predation of fruits (U.S. Army Garrison 2005b). Thus, *C. superba* ssp. *superba* is characterized by two population units that have met minimum numeric stabilization criteria, and have increased significantly since listing (no naturally occurring individuals in existence) due to reintroduction of greenhouse-propagated plants.

Table SB 11. Range Wide Distribution of *Cyanea superba* ssp. *superba*

Population Units	Numbers of Known Individuals						
	1991 (1)	**1995** (2)	**1998** (3)	**2003** (4)	**2004** (5)	**2005** (6)	**2006** (7)
Kahanahaiki*	--	--	--	1 [251]§	0/0‡ [2/149]	0/0 [78/62]	0/0 [99/56]
Pahole to Kapuna*	--	--	--	0 [120]	0/0 [31/139]	0/0 [29/148]	0/0 [72/84]
Central & East Makaleha*	--	--	--	0	0	0	0
Makaha*	--	--	--	0	0	0	0
Total Individuals	**<20**	**<10**	**5**	**372** (1) [371]	**457** (0/0)† [33/424]	**453** (0/0) [107/346]	**311** (0/0) [171/140]

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals

†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (56 FR 46235)
(2) Recovery Plan (Service 1995a)
(3) Recovery Plan (Service 1998a)
(4) Makua Implementation Plan (Makua Implementation Team 2003)
(5) MIP Addendum and 2005 status report (U.S. Army Garrison 2005a, 2005b)
(6) 2005 status report (U.S. Army Garrison 2005b)
(7) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Cyanea superba* ssp. *superba* usually grows in the understory of mesic forest on well-drained rocky substrate on sloping terrain at elevations between 232 and 872 m (761 and 2,860 ft). Flowering season varies from year to year depending on rainfall, usually from late August to early October and peaking in early to mid-September. Fruits mature in two to five months (68 FR 35950). The long tubular flowers and yellow-orange berries suggest pollination and seed dispersal by birds may be common. As with other *Cyanea* species with long tubular flowers, *C. superba* ssp. *superba* likely was pollinated by nectar-feeding birds. It is capable of self-pollination, as evidenced by the fact that isolated plants produce viable seeds. Recent research indicates native bees (genus *Hylaeus*) and the non-native Japanese white-eye bird (*Zosterops japonicus*) also may pollinate this subspecies (U.S. Army Garrison 2005b). The longevity of *C. superba* ssp. *superba* is unknown, but may be up to 20 years as indicated by observed growth rates and the size of mature plants (Makua Implementation Team 2003). Other demographic information for *Cyanea superba* ssp. *superba* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats *Cyanea superba* ssp. *superba* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section, and are tabulated in Appendix E. This subspecies is particularly vulnerable to predation by rats and slugs. Rats must be controlled during the fruiting season so that seed may be collected for propagation. Slugs likely attack all members of this genus, as suggested by investigations of the related *Cyanea angustifolia* and *Cyanea superba* ssp. *superba* (U.S. Army Garrison 2005b). Slugs reduce the survival of *C. angustifolia* seedlings by up to 80 percent and of *C. superba ssp. superba* by up to 70 percent. Research suggests that slug control using a combination of molluscacide and copper mesh barrier may increase *C. superba* ssp. *superba* seedling survival by up to 100 percent (U.S. Army Garrison 2005b).

Occurrences of *Cyanea superba* ssp. *superba* are vulnerable to extirpation from habitat degradation by feral ungulates; competition with various non-native plants; wildfire; military activities; and/or reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by rat or slug predation, erosion, landslides, and rockslides (61 FR 53089; 68 FR 35950; Service 1998a). This subspecies has a history of precipitous decline and extremely low genetic variability; any catastrophic disturbance during a major low point could extirpate one or more population units or result in the extinction of the species in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *C. superba* ssp. *superba* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. In addition, the long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *C. superba* ssp. *superba* have been almost totally extirpated from the Waianae Mountains. Although this subspecies is capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003). Low genetic variability and small population size usually result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor. Although *C. superba* ssp. *superba*, outplants seem to be vigorous and produce viable seed, reduced genetic variability could result in potentially deleterious consequences for long-term persistence of the subspecies. Thus, *C. superba* ssp. *superba* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

<u>Conservation Needs of the Species</u> Conservation actions that should be implemented for the recovery of *Cyanea superba* ssp. *superba* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). A stabilization target of at least 50 mature, reproducing individuals is needed per population unit to attain stability for this short-lived perennial because large fluctuations in numbers and a recent history of decline (Makua Implementation Team 2003). In general, stabilization of *C. superba* ssp. *superba* will depend on addressing threats to seedlings (U.S. Army Garrison 2005b). Particular conservation needs include research on slug control measures in forest settings and rat control during the fruiting and seed collection season.

<u>Ongoing Conservation Actions</u> The Makua Implementation Team (2003) has developed stabilization protocols for *Cyanea superba* ssp. *superba*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This subspecies is located in occurrences over three management units where it will benefit from population unit and/or ecosystem-level protection: Kahanahaiki, Pahole, and Upper Kapuna.
In addition, all reintroductions are within fenced ungulate exclosures. Rats are partially controlled in the Kahanahaiki and Honouliuli population units. Weeds are controlled in the Kahanahaiki population unit and partially controlled in the Pahole to Kapuna population unit. Reintroduced plants in all population units are within fenced ungulate exclosures (U.S. Army Garrison 2005b).

Cyanea superba ssp. *superba* can be successfully propagated from seed but not by cuttings. Ample seed is available each year from reintroduced plants, albeit from a limited number of founders. Germination rates of fresh seed are highly variable (0 to 95 percent) among different plants. Seed storage potential appears to be very low; seeds are collected from outplanted individuals every two years to keep viable seeds in storage. Survival of reintroduced individuals is enhanced by outplanting two-year-old plants about 1 m (3.3 ft) tall, and by selecting outplanting sites in gulch bottoms rather than on rocky slopes (U.S. Army Garrison 2005b). As of 2005, there were several *ex situ* collections for *C. superba* ssp. *superba*, including 47 vegetative buds in micropropagation (Harold L. Lyon Arboretum), three cuttings in a nursery (Harold L. Lyon Arboretum), nine plants in botanical garden (Waimea Valley Audubon Center), 2,176 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 52,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 47 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 884 ha (2,185 ac) in four separate units were designated for *Cyanea superba* ssp. *superba*. The units were designated on State land (Mokuleia and Honolulu Watershed Forest Reserves, and Pahole and Kaala Natural Area Reserves), and on private land. Two of the critical habitat units each provide habitat for four populations of 300 mature, reproducing individuals, one unit provides habitat for two populations, and one unit provides habitat for one population. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *Cyanea superba* ssp. *superba* (68 FR 35950).

The primary constituent elements of critical habitat include mesic forest on sloping terrain on a well-drained rocky substrate at elevations between 232 and 872 m (761 and 2,991 ft). In addition, all units contain one or more of the following associated native plant species: *Diospyros* sp., *Hedyotis terminalis*, *Metrosideros polymorpha*, *Nestegis sandwicensis*, *Pisonia brunoniana*, *Psychotria* sp., or *Xylosma* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 50 percent of all known individuals of *Cyanea superba* ssp. *superba* are located within the action area, in the Kahanahaiki population unit (see Table SB 11). The last naturally occurring plant in the wild died in the Kahanahaiki population unit in 2002. The Army had begun reintroducing plants to this population unit in 1999. Survivorship of outplants varied from 35 percent at marginal sites to 80 percent at the best sites. Survivorship of State outplantings since 2001 in the Pahole to Kapuna population unit is about 60 percent (U.S. Army Garrison 2005b). *Cyanea superba* ssp. *superba* plants in the action area are located in low and very low fire risk zones for training-related wildfire. About 21 individuals occur in the low fire risk zone and 134 are in the very low fire risk zone, and represent about 50 percent of the subspecies' total range-wide individuals. Thus, *C. superba* ssp. *superba* in the action area is characterized by one population unit reaching numerical criteria for stabilization (50 mature individuals) comprising 50 percent of all remaining plants, however they are not successfully reproducing in the wild due to uncontrolled threats, and are located in zones at low and very low risks of training-related wildfire.

Status of Critical Habitat in the Action Area The action area contains a total of 206.6 ha (510.5 ac), or 23 percent of the total critical habitat for *Cyanea superba* ssp. *superba*. Designated critical habitat is located within one unit in the eastern portion of the action area. This critical habitat is a portion of a larger 302.4-ha (747.2-ac) critical habitat unit that extends outside the action area boundary and provides habitat for four populations of *Cyanea superba* ssp. *superba*. Critical habitat for this subspecies in the action area is located in an area at risk of training-related wildfire, with 0.2 ha (0.5 ac) located in the high fire risk zone, 17.1 ha (42.3 ac) in the low fire risk zone, and 189.3 ha (467.7 ac) in the very low fire risk zone. More than one-half of the critical habitat is located in forest habitat with greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Cyanea superba* ssp. *superba* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Cyanea superba* ssp. *superba* in the action area is particularly vulnerable to rat and slug predation. About 23 percent of critical habitat for this subspecies is located in an area at high, low, and very low risks of training-related wildfire. Thus, because about 50 percent of all known individuals occur within the action area and the history of precipitous decline, *C. superba* ssp. *superba* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Cyanea superba* ssp. *superba* because 50 percent of the known plants and no population units meeting minimum numerical criteria for stabilization exist outside the action area. Furthermore, because of its history of precipitous decline and low numbers of mature individuals, this subspecies is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Four population units have been identified for expedited stabilization of *Cyanea superba* ssp. *superba*: Kahanahaiki in the action area, and Central and East Makaleha, Makaha, and Pahole to Kapuna outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *Cyanea superba* ssp. *superba* and associated native plants. Other general conservation needs of the subspecies and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Kahanahaiki population unit, which contains 50 percent of the total remaining individuals of *Cyanea superba* ssp. *superba*, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2006d). These individuals are located within the Kahanahaiki (subunit II), Pahole, and Upper Kapuna Management Units. Only the Pahole Management Unit is surrounded by a large-scale fence, but all reintroductions of this subspecies are within small fenced exclosures. Rats are controlled during the Oahu elepaio breeding season in the Kahanahaiki Management Unit and weeding is conducted several times a year. A total of about 270.9 ha (669.9 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Kaimuhole, Manuwai, Pahole, Upper Kapuna, West Makaleha). About 182.6 ha (451.3 ac) of the total critical habitat that is within management units is located inside the action area (Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were less than one percent complete, with only one plant meeting the goals outlined in the Makua Implementation Plan. In addition, there were two plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat– *Cyrtandra dentata* (Haiwale)

<u>Species Description</u> *Cyrtandra dentata* is a member of the Gesneriaceae (African violet) family. It is a short-lived perennial shrub 1.5 to 5 m (5 to 16 ft) tall with sparsely branched stems. The leaves have a papery texture, are oppositely arranged, very broadly elliptical to suborbicular or broadly ovate to ovate, 9 to 33 cm (3.5 to 13.0 in) long, and 6 to 17-cm (2.4 to 6.7 in) wide. The 8 to 23 cm (3 to 9 in) tall inflorescences are open cymes that originate from the leaf axils. The fruit is 1 to 2 cm (0.4 to 0.8 in) long and contains many minute seeds. This species is distinguished from others in the genus by the number and arrangement of the white flowers, the length of the bracts and flower stalks, and the shape of the leaves (Wagner et al 1999).

<u>Listing Status</u> *Cyrtandra dentata* was federally listed as endangered on October 10, 1996, and State listed as endangered in Hawaii at the same time (61 FR 53108). A recovery plan was prepared for this species (Service 1998a), and critical habitat was designated on June 17, 2003 (68 FR 35950).

<u>Historic and Current Distribution</u> *Cyrtandra dentata* is a species endemic to Oahu and was historically known from six occurrences in the Waianae Mountains and three occurrences in the Koolau Mountains. Currently, this species is found at Kawaiiki Gulch, Opaeula Stream, Kahanahaiki, and Pahole to Kapuna to West Makaleha (Table SB 12). There are a total of 1,521 individuals in the four known population units. More than 90 percent of the *C. dentata* populations are located on Federal, State, city/county, and private lands. Trends in numbers and reproduction of *C. dentata* populations were declining, but have responded well to ungulate control and are currently increasing (Service 2003b; L. Durand, pers. comm. 2004; U.S. Army Garrison 2005c). Currently, *C. dentata* is characterized by two populations exceeding minimum numerical criteria (more than 50 mature, reproducing individuals) and two population units that have not met minimum numerical criteria on Oahu.

Table SB 12. Range-wide Distribution of *Cyrtandra dentata.*

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Total Number of Individuals</th></tr>
<tr><th>1996
(1)</th><th>1998
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kahanahaiki</td><td>--</td><td>--</td><td>52/45‡</td><td>156/6</td><td>156/84</td><td>156/84</td></tr>
<tr><td>Pahole to West Makaleha*</td><td>--</td><td>--</td><td>300</td><td rowspan="2">478/470</td><td rowspan="2">488/644</td><td rowspan="2">508/648</td></tr>
<tr><td>Kapuna</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Kawaiiki (Koolau) *</td><td>--</td><td>--</td><td>50</td><td>21/33</td><td>19/78</td><td>19/78</td></tr>
<tr><td>Opaeula (Koolau) *</td><td>--</td><td>--</td><td>21/5</td><td>21/12</td><td>16/12</td><td>16/12</td></tr>
<tr><td>Total Individuals on Oahu</td><td><50</td><td><70</td><td>473
(423/50)†</td><td>1197
(676/521)</td><td>1497
(679/818)</td><td>1525
(703/822)</td></tr>
</table>

Shaded population units are inside the action area.
‡mature/immature individuals
*Stabilization population units
†Total (mature/immature)

(1) Listing rule (61 FR 53108)
(2) Recovery plan (Service 1998a)

(3) MIP (MIT 2003), Oahu Biological Opinion (Service 2003a)
(4) MIP Addendum and 2004 status update (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(5) Critical habitat rule (68 FR 35950
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Cyrtandra dentata* typically grows in lower gulch bottoms, wet slopes, stream banks, or ravines in mesic forest in the Waianae Mountains and in wet forest in the Koolau Mountains. It is found between 255 and 953 m (836 and 3,126 ft) in elevation. *Cyrtandra dentata* has been observed in flower and fruit in May and November. The reproductive biology of *C. dentata* has not been studied. However, a study of *Cyrtandra grandiflora* on Oahu showed that it is self-compatible and that both self-pollination and cross-pollination require an unknown insect pollinator. It was also found that there is a strong tendency for a flower's pollen to be shed before the flower's stigma becomes receptive to pollen, thereby decreasing the likelihood of self-pollination. The dispersal agents are unknown, although its white berries suggest dispersal by fruit-eating birds. Other demographic information for *C. dentata* in the wild is unknown, including its longevity, which is presumed to be less than 10 years. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, specific environmental requirements, and limiting factors (Service 2003b). There is very little information on population trends for this species. It is possible that the species' numbers are rising in places that have been fenced to exclude pigs over the last decade, such as Pahole Gulch in the Pahole Natural Area Reserve and Kahanahaiki Gulch in Makau Military Reservation. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 2003a).

Threats to the Species *Cyrtandra dentata* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described under the "General Status and Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In addition, *C. dentata* is vulnerable to predation by rats and introduced slugs and habitat degradation from stochastic events such as landslides, hurricanes, and flooding. Rats pose a threat through consumption of the plant. Introduced slugs and snails threaten the taxon by feeding on its leaves, stems, and seedlings. A study has shown that introduced slugs significantly reduce seedling survival in this species (U.S. Army Garrison 2003b; Service 2003b; Joe and Daehler 2005; 68 FR 35950). *Cyrtandra dentata* is vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (61 FR 53108; Service 1999b). Thus, *C. dentata* has a moderate background risk of extinction, and any additional threats would eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Cyrtandra dentata* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). At least 50 mature, reproducing individuals are needed per population unit to attain stability for short-lived perennials. All known occurrences of *C. dentata* should be fenced and non-native plants should be removed from the vicinity of each occurrence.

The threat from rats should be evaluated at all known occurrences of *C. dentata*. Research and implementation of control methods for slugs is also needed (Service 2003b).

Ongoing Conservation Actions Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Cyrtandra dentata* which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In 1997, the Hawaii Department of Forestry and Wildlife constructed fenced enclosures to protect all *C. dentata* occurrences, and feral pigs and goats were removed. Control of the invasive plants *Clidemia hirta, Psidium cattleianum*, and *Schinus terebinthifolius* is being conducted in these and surrounding areas. *Cyrtandra dentata* is being propagated at the Lyon Arboretum (Koob 1996; Service 2003b; Hawaii and Pacific Plant Recovery Committee 2007). *Cyrtandra dentata* can be successfully propagated from seed, air layers and cuttings. It is represented in several *ex situ* collections.

Critical Habitat Description A total of 306 ha (756 ac) has been designated for *Cyrtandra dentata* in one unit on the island of Oahu. Critical habitat was designated on State land (Mokuleia Forest Reserve and Pahole Natural Area Reserve). This unit provides habitat for a total of three populations, each with a minimum of 300 mature, reproducing individuals (68 FR 35950). The primary constituent elements include gulches, slopes, stream banks, or ravines in mesic or wet forest containing one or more of the following associated native plant species: *Acacia koa*, *Metrosideros polymorpha*, *Pipturus albidus*, *Pisonia sandwicensis*, *P. umbellifera*, *Pouteria sandwicensis*, *Syzygium sandwicensis*, or *Urera glabra*; and elevations between 319 and 880 m (1,046 and 2,886 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Approximately 92 percent of all known individuals of *Cyrtandra dentata* are located within the action area in the Kahanahaiki and Pahole to Kapuna to West Makaleha population units. Both population units are at risk from training-related wildfire, but are in the low fire risk zone. Trends in numbers indicate an overall increase from less than 50 individuals in 1996 to more than 1,396 individuals in the action area in 2006, due to augmentation of immature plants and discovery of new mature individuals in the wild. There are approximately 240 individuals from the Kahanahaiki population unit in the low fire risk zone and 1,100 individuals from the Pahole to Kapuna to West Makaleha population unit also in the low fire risk zone (Service 2005b; Koob 2006). Both population units are found growing in several gulches over a widespread area and have more than 50 mature, reproducing individuals (the minimum number suggested for stabilization populations for this species). These population units are the center of abundance for this species, so even though they are both found in the action area, they are also both designated to be managed for stability. Demographic data shows that roughly 45 percent of the total individuals in the action area are mature and 55 percent are immature augmentations. Because the plants are spread over a large area, the risk from one catastrophic event impacting all plants is reduced (U.S. Army Garrison 2005c).

Status of the Critical Habitat in the Action Area Sixty-eight percent (208 ha; 514 ac) of the State-wide and Oahu-wide designated critical habitat for *Cyrtandra dentata* is located in the Makua action area. About 68 percent of critical habitat for this species is located in an area at risk from training-related wildfire, with less than one percent located in the high fire risk zone. Approximately 0.2 ha (0.6 ac) are in the high fire risk zone, 18 ha (44 ac) are in the low fire risk zone and 190 ha (469 ac) are in the very low fire risk zone. This critical habitat unit, in combination with 98 ha (243 ac) outside the Makua action area, provides habitat for the conservation of three populations, each with at least 300 mature, reproducing individuals of *C. dentata*. It is estimated that more than one-half of the critical habitat is located in forest habitat with greater than 50 percent native cover (U.S. Army Garrison 2003b; Service 2003a; K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Cyrtandra dentata* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In addition, *C. dentata* is vulnerable to predation by rats and introduced slugs, habitat degradation caused by black twig borer, Chinese rose beetles, and habitat degradation from stochastic events such as landslides, hurricanes, and flooding. Rats pose a threat through consumption of the plant and its fruits. Introduced slugs and snails threaten the taxon by feeding on its leaves, stems, and seedlings. A study has shown that introduced slugs significantly reduce seedling survival in this species (U.S. Army Garrison 2003b; Service 2003b; Joe and Daehler 2005; 68 FR 35950). Thus, because about 92 percent of all known State-wide individuals occur within the action area, *C. dentata* in the action area has a moderate background risk of species extinction, and any additional threats would eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Cyrtandra dentata* because no populations with more than 50 mature, reproducing individuals exist outside the action area. Four population units have been identified for stabilization management: Kahanakaiki, Pahole to Kapuna to West Makaleha, Kawaiiki and Opaeula. Stabilization actions as outlined in the Makua Implementation Plan will be implemented to stabilize this taxon. To be considered stable, *C. dentata* must meet the criteria required for stability of a short-lived perennial species. The stabilization measures will include surveys for additional occurrences, collection and propagation of this taxon for genetic storage and reintroduction into the wild, monitoring and management of known population units as identified in the Makua Implementation Plan, ungulate control, development and implementation of slug control at reintroduction sites and elsewhere where deemed necessary, and rat control around the reintroduced individuals and other population units, if necessary (Service 2003b).

Ongoing Conservation Actions for the Species and Critical Habitat within the Action Area The Pahole to Kapuna to West Makaleha population unit, which contains 75 percent of the total remaining individuals of *Cyrtandra dentata* on Oahu, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b).

The Army has fenced all the known individuals of this species in the Kahanahaiki Management Unit. This resulted in an increase in all size classes (seedlings, juveniles, and mature plants) at the site. Seeds were collected in 2004 for storage testing. The rat control that is conducted for a nesting Elepaio pair may also benefit this population unit. Control of non-native plants is occurring within the Kahanahaiki Management Unit, particularly for *Clidemia hirta*. In addition, the Army is monitoring for additional threats or changes in the population of *Cyrtandra dentata* (U.S. Army Garrison 1999a; Service 2003b; K. Kawelo, pers. comm. 2004). The Pahole portion of the Pahole to Kapuna to West Makaleha population unit is fenced. The Kapuna portion is scheduled to be fenced in the first year of the Makua Implementation Plan. This area was partially monitored this year and large numbers of individuals of all size classes were counted. Plants in this population unit appeared healthy and were recruiting well. In July 2004, seeds were collected from this population unit for storage testing (U.S. Army Garrison 2005c). Genetic storage goals for *C. dentata* are less than one percent (4/200) complete. The Army currently controls non-native plants and ungulates within the Pahole to Upper Kapuna to West Makaleha Management Units (U.S. Army Garrison 1999a; Service 2003b; K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Delissea subcordata* (No Common Name)

Species Description *Delissea subcordata* is a short-lived perennial in the Campanulaceae (bellflower family). It is a shrub 1 to 3 m (3.5 to 10 ft) tall with a single stem or occasionally branched. The leaves have toothed or cut margins, are 12 to 30 cm (4.7 to 11.7 in) long, and are clustered at the stem tips. Inflorescences are borne close to the stem among the leaves, with curved, white to green flowers 45 to 60 mm (1.8 to 2.4 in) long. The purple berries are 12 to 16 mm (0.5 to 0.6 in) long (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Delissea subcordata* was federally listed as endangered on October 10, 1996 (61 FR 53089), and was State listed as endangered at the same time. This species was included in the recovery plan for Oahu plants (Service 1998a). Critical habitat was designated for *D. subcordata* on June 17, 2003 (68 FR 35950). Four (44 percent) of the nine *Delissea* species are listed as endangered and several are presumed extinct (Service 2006a, Hawaii Biodiversity and Mapping Program 2006).

Historic and Current Distribution *Delissea subcordata* is a species endemic to Oahu. Historic survey data indicate *D. subcordata* was known from 21 scattered populations in the Waianae Mountains and eight populations in the Koolau Mountains. This species is absent from several locations in the Waianae Mountains where it was found in the 1970s and 1980s, and it is no longer found in the Koolau Mountains. When *D. subcordata* was listed in 1996, there were about nine occurrences totaling 70 to 80 individuals (61 FR 53089). According to the Army, this species currently is "very rare and continues to decline in numbers" (U.S. Army Garrison 2005b). Recent survey data indicate there are currently 185 total individuals in seven population units located on Federal, State, and private lands (Table SB 13) (U.S. Army Garrison 2006d). None of these population units are exceeding minimum numeric criteria for stabilization (defined as 100 mature, reproducing individuals per population unit).

Since 2003, numbers in the Waianae Mountains five population units have decreased, remained the same in one population unit, and increased in one population unit. Although two population units have been extirpated, overall numbers of this species have increased. All increases are due to augmentation and perhaps to some new discoveries; the number of naturally occurring plants has declined slightly or remained the same in all population units. New plants were discovered in the Kahanahaiki to Keawapilau and Palikea population units, and a new population of seven mature individuals was discovered in 2004 on State land at Kealia/Haili. All *D. subcordata* plants in the Huliwai and Kaawa population units have died since 2003, and there is no genetic stock remaining from these population units (U.S. Army Garrison 2005b). The Kahanahaiki to Keawapilau population units are located within low and very low fire risk zones for training-related wildfire at Makua (U.S. Army Garrison 2005b).

Demographic data for this species indicate that about 83 percent of all remaining *Delissea subcordata* plants are augmented individuals from greenhouse-propagated stock. About 94 percent of all individuals are mature plants. This species has been reintroduced on Federal, State, and private (The Nature Conservancy of Hawaii) lands. There is recruitment at wild sites and new plants are occasionally found away from known occurrences, suggesting dispersal by birds or possibly persistence of a soil seedbank (U.S. Army Garrison 2005b). Thus, *D. subcordata* is characterized by seven population units not meeting minimum numeric criteria for a stabilization population unit, declines of naturally occurring individuals in five population units, and an overall increase in numbers due to augmentation/reintroduction of greenhouse-propagated stock.

Table SB 13. Range-wide Distribution of *Delissea subcordata*

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Numbers of Known Individuals</th></tr>
<tr><th>1996
(1)</th><th>1998
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kahanahaiki*</td><td>--</td><td>--</td><td>1</td><td rowspan="3">5/0‡
[24/1]§</td><td rowspan="3">4/0
[21/1]</td><td rowspan="3">4/0
[18/0]</td></tr>
<tr><td>Kapuna and Keawapilau*</td><td>--</td><td>--</td><td>9</td></tr>
<tr><td>Pahole*</td><td>--</td><td>--</td><td>6</td></tr>
<tr><td>Ekahanui*</td><td>--</td><td>--</td><td>14</td><td>3/1
[0/44]</td><td>4/0
[81/0]</td><td>4/0
[109/0]</td></tr>
<tr><td>Huliwai</td><td>--</td><td>--</td><td>7</td><td>0</td><td>0/0</td><td>0/0</td></tr>
<tr><td>Kaawa</td><td>--</td><td>--</td><td>2</td><td>0</td><td>0/0</td><td>0/0</td></tr>
<tr><td>Kaluaa*</td><td>--</td><td>--</td><td>1</td><td>1/1
[43/0]</td><td>1/1
[34/0]</td><td>1/11
[27/0]</td></tr>
<tr><td>Kealia/Haili</td><td>--</td><td>--</td><td>--</td><td>7/0</td><td>2/0</td><td>2/0</td></tr>
<tr><td>Palawai</td><td>--</td><td>--</td><td>1</td><td>2/3</td><td>2/3</td><td>5/0</td></tr>
<tr><td>Palikea Gulch</td><td>--</td><td>--</td><td>2</td><td>2/0</td><td>1/0</td><td>2/0</td></tr>
<tr><td>South Mohiakea (SBMR)</td><td>--</td><td>--</td><td>2</td><td>1/1</td><td>1/0</td><td>1/1</td></tr>
<tr><td>Total Individuals</td><td>70-80</td><td><80</td><td>45</td><td>139
(21/6)†
[67/45]</td><td>156
(15/4)
[136/1]</td><td>185
(19/12)
[154/0]</td></tr>
</table>

Shaded population units are inside the action area.
* Stabilization population units
SBMR = Schofield Barracks Military Reservation.
‡Total mature/immature individuals

†Total (mature/immature)
§[augmented and or reintroduction]

(1) Listing rule (61 FR 53089)
(2) Recovery Plan (Service 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Delissea subcordata* typically grows on north-facing gulch slopes and sometimes in gulch bottoms in mixed mesic forests dominated by *Diospyros sandwicensis*, *Metrosideros polymorpha*, and/or *Acacia koa* at elevations between 162 and 1,025 m (531 and 3,362 ft) (Makua Implementation Team 2003). This species also survives relatively well in weedy forests dominated by the non-native *Schinus terebinthifolius* and *Psidium cattleianum*. Flowering and fruiting has been documented at various times of the year, with peak flowering from February through June followed by fruiting from June through August. Similar to other *Delissea* species with long tubular flowers and colorful berries, this species likely was pollinated by nectar-feeding birds and its fruit dispersed by fruit-eating birds. However, *D. subcordata* is capable of self-pollination, as evidenced by the production of viable seeds by isolated plants. The longevity of the plants is unknown; individuals presumably live for less than 10 years like other taxa of this size in the genus *Delissea* and in the closely-related genus *Cyanea* (Makua Implementation Team 2003). Other demographic information for *D. subcordata* in the wild is unknown, including longevity, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats *Delissea subcordata* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. This species is particularly vulnerable to predation by rats and slugs. Slugs are a threat to seedlings of this species and slug damage has been observed on plants of all size classes.

Occurrences of *Delissea subcordata* are vulnerable to extirpation from habitat degradation by feral ungulates; competition with various non-native plants; wildfire; military activities; and/or reduced reproductive vigor due to small population size and limited distribution as well as direct destruction of individual plants by rat or slug predation, erosion, landslides, and rockslides (61 FR 53089; 68 FR 35950; Service 1998a). This species has a history of population fluctuation and local declines, and may be an obligate out-crosser. Therefore, any catastrophic disturbance during a major low point could extirpate on or more population units and may result in the extinction of the species in the wild (Makua Implementation Team 2003). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *D. subcordata* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. In addition, the long-billed, nectar-feeding native Hawaiian birds that were the presumed pollinators of *D. subcordata* have been almost totally extirpated from the Waianae

Mountains. Although this species may be capable of self-pollination, the loss of its natural pollinators has likely resulted in decreased genetic variability (Makua Implementation Team 2003). Low genetic variability and small population size usually result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor that could result in potentially deleterious consequences for long-term persistence of the species. Thus, *D. subcordata* has a very high background risk of species extinction and any additional threats would eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Delissea subcordata* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). A stabilization target of at least 100 mature, reproducing individuals is needed per population unit to attain stability for this short-lived perennial because large fluctuations in numbers and a recent history of decline (Makua Implementation Team 2003).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Delissea subcordata*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Kahanahaiki to Keawapilau population unit is partially fenced; the South Mohiakea, Ekahanui, Kaluaa, and Palawai population units are in fenced management units or smaller fenced exclosures. Rats are controlled in the West Makaleha reintroduction, the only site where rat damage has been observed (U.S. Army Garrison 2005b). In addition, this species is located in occurrences over five management units where it will benefit from population unit and/or ecosystem-level protection: Ekahanui, Kahanahaiki, Kaluaa and Waieli, Pahole, Upper Kapuna.

Delissea subcordata can be successfully propagated from seed, and seed can be stored for up to five years with little or no decrease in viability. Lab germination rates are about 90 percent. Survival of all reintroductions has been at least 80 percent and seedlings have been observed at one site in the Kahanahaiki area of the Kahanahaiki to Keawapilau population unit (U.S. Army Garrison 2005b). As of 2005, this species was represented in several *ex situ* collections, including five cuttings in a nursery (Harold L. Lyon Arboretum), three plants in a botanical garden (Waimea Valley Audubon Center), 694 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 110,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 103 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 1,517 ha (3,748 ac) of critical habitat was designated in six separate units for *Delissea subcordata*. Critical habitat was designated on State land (Mokuleia Forest Reserve, and Pahole and Kaala Natural Area Reserves) and private land (Honouliuli Preserve). One of the critical habitat units provides habitat for four populations, two units combined provide habitat for three populations, and each of three units provides habitat for one population. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *Delissea subcordata* (68 FR 35950).

The primary constituent elements of critical habitat include moderate to steep gulch slopes in mixed mesic forests at elevations between 179 and 928 m (587 and 3,044 ft). In addition, all units contain one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* sp., *Bobea* sp., *Claoxylon sandwicense*, *Chamaesyce multiformis*, *Charpentiera obovata*, *Diospyros hillebrandii*, *D. sandwicensis*, *Hedyotis acuminata*, *Metrosideros polymorpha*, *Myrsine lanaiensis*, *Nestegis sandwicensis*, *Pisonia* sp., *Pouteria sandwicensis*, *Psychotria hathewayi*, *Psydrax odorata*, or *Streblus pendulinus*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

<u>Threats to the Critical Habitat</u> See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

<u>Status of the Species in the Action Area</u> About 12 percent of all known individuals of *Delissea subcordata* are located within the action area, in the Kahanahaiki to Keawapilau population unit (see Table SB 13). Since 2003, the number of naturally occurring individuals have declined from 16 to four, and this population unit has been augmented with 18 surviving outplants. *Delissea subcordata* plants in the action area are located in areas at risk of training-related wildfire. About 20 individuals occur in the low fire risk zone and two are in the very low fire risk zone, and represent about 20 percent of the species' range-wide total plants. Thus, *D. subcordata* in the action area is characterized by one population unit not exceeding numerical criteria for stabilization (100 mature individuals) comprising 12 percent of all remaining individuals, with numbers that have increased solely due to augmentation, and which are located within low and very low fire risk zones for training-related wildfire.

<u>Status of Critical Habitat in the Action Area</u> The action area contains a total of 186.8 ha (461.6 ac), or 12 percent of the total critical habitat for *Delissea subcordata*. Designated critical habitat is located within one unit in the eastern portion of the action area. This critical habitat is a portion of a larger 763.4 ha (1,886.5 ac) critical habitat unit that extends outside the action area boundary and provides habitat for four populations of *D. subcordata*. Critical habitat for this species in the action area is located in an area at risk of training-related wildfire, with 0.2 ha (0.6 ac) located in the high fire risk zone, 13.0 ha (32.2 ac) in the low fire risk zone, and 173.5 ha (428.7 ac) in the very low fire risk zone. More than half of the critical habitat is located in forest habitat with greater than 50 percent native cover (K. Kawelo, pers. comm. 2004; Service 2004).

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Delissea subcordata* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Delissea subcordata* in the action area is particularly vulnerable to rat and slug predation. About 12 percent of critical habitat for this species is located in an area at risk of training-related wildfire. Thus, because about 12 percent of all known individuals occur within the action area and a there is a history of local declines, *D. subcordata* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area   The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Delissea subcordata* because no population units meeting minimum numerical criteria for stabilization exist outside the action area. Furthermore, because of its low numbers and history of local declines, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Four population units have been identified for expedited stabilization of *D. subcordata*: Kahanahaiki to Keawapilau in the action area, and Ekahanui and Kaluaa outside the action area. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *D. subcordata* and associated native plants. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area   The Kahanahaiki to Keawapilau population unit, which contains 12 percent of the total remaining individuals of *Delissea subcordata*, is being managed for stabilization as specified in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located within the Kahanahaiki (subunit II), Pahole, and Upper Kapuna Management Units. The Kahanahaiki to Keawapilau population unit is partially fenced and partially controlled for weeds. A total of about 351.4 ha (868.0 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Ekahanui, Kahanahaiki, Kaluaa and Waieli, Manuwai, Pahole, Palikea, Upper Kapuna, West Makaleha). About 155.9 ha (385.4 ac) of the total critical habitat that is within management units is located inside the action area (Kahanahaiki, Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were about six percent complete, with 27 plants meeting the goals outlined in the Makua Implementation Plan. In addition, there were 10 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Diellia falcata* (Pu u Pane)

Species Description   *Diellia falcata* is a short-lived perennial fern in the Aspleniaceae family. It grows from a rhizome 1 to 5 cm (0.4 to 2 in) long and 0.5 to 2 cm (0.2 to 0.8 in) in diameter, which is covered with small black or maroon scales. This species is distinguished from others in the genus by the color and texture of its leaf stalk, the venation pattern of its fronds, the color of its scales, its rounded and reduced lower pinnae (leaflets), and its separate sori (spore clusters) arranged on marginal projections (Palmer 2003; Makua Implementation Team 2003).

Listing Status   *Diellia falcata* was federally listed as endangered on October 29, 1991 (56 FR 55770), and State listed as endangered in Hawaii at the same time. A recovery plan was prepared for this species in 1998 (Service 1998b). Critical habitat was designated for this species on Oahu on June 17, 2003 (68 FR 35950).

Historic and Current Distribution   Historically, *Diellia falcata* was known from almost the entire length of the Waianae Mountains, from Manini Gulch to Palehua Iki, as well as from the Koolau Mountains of Oahu, from Kaipapau Valley to Aiea Gulch. Currently, *D. falcata* is locally common in the Waianae Range, but it is probably extirpated from the Koolau Range. Botanists do not make accurate counts of this taxon as it is locally common in some areas of the Waianae Mountains. According to the status as summarized in the Endangered Species Mitigation Plan (Service 1999b) from the Makua Biological Assessment, *D. falcata* is known from 22 populations with between 5,540 to 6,540 individuals. There are at least three populations outside the Makua and Oahu action areas with more than 50 mature, reproducing individuals, the minimum number suggested for stabilization populations for this species (Table SB 14) (U.S. Army Garrison 2005). *Diellia* is endemic to Hawaii and includes six species, which all may have originated from a single common ancestor (Palmer 2003). Three of the taxa are endemic to Oahu. *Diellia falcata* is the only species showing slightly higher abundance. It is sparsely distributed throughout the whole of the Waianea Mountains (Aguraiuja and Wood 2002, 2003; Aguraiuja 2001). *Diellia falcata* is the only species in the genus that seems to be maintaining viable populations (L. Durand, pers. comm., 2004)

Table SB 14. Range-wide Distribution of *Diellia falcata*.

Occurrences	Number of Known Individuals						
	(1991) (1)	**1999** (2)	**2002** (3)	**2003** (4)	**2004** (5)	**2005** (6)	**2007** (7)
Kahanahaiki	--	>200	~400/600‡	--	96/62	267/1,071	230/1,035
Huliwai	--	--	--	--	35/163	--	--
S.-Ekahanui	--	--	--	--	6/1	--	--
Waianae Kai	--	--	--	--	62/211	--	--
S.-Palawai	--	--	3/15	--	3/13	--	--
N.-Palawai	--	--	35/15	--	--	--	--
Pualii	--	--	--	--	5/3	--	--
Makaha	--	--	~700/300	--	--	--	--
Total Occurrences	7	22	5	30	7	22	15
Total Individuals	**~3000**	**5540-6540**	**>2000**	**<6000**	**660** (207/453)†	**thousands**	**thousands**

Shaded occurrences are inside the action area.
‡Mature/immature individuals
†Total (mature/immature)
(1) Listing rule (56 FR 55770)
(2) Makua Endangered Species Mitigation Plan (Service 1999b)
(3) Aguraiuja and Wood. 2002
(4) Critical Habitat (68 FR 35950)
(5) Aguraiuja et al 2004
(6) Army re-initiation request (U.S. Army Garrison 2005c)
(7) Army database (U.S. Army Garrison 2006d)

Ecology *Diellia falcata* is a terrestrial fern that typically grows in deep shade or open understory on moderate to moderately steep slopes and gulch bottoms in diverse mesic forest between 224 and 953 m (735 and 3,126 ft) elevation. Typically, *Diella* sp. is restricted to spatially fragmented habitat type on the steep sides of gulches. Plants gow on soil that is rocky, granular and usually dry, with some leaf litter and mosses (Aguraiuja 2001). *Diellia falcata*, currently the most successful *Diellia* species, is known from almost the entire length of the Waianae Mountains on Oahu, with 14 larger occurrences (40 to 2,000) and eight occurrences smaller than 10 individuals (Service 1999a). Fronds bearing sori (spores) have been observed year-round (Service 1998b). Aguraiuja observed the Kahanahaiki population of *D. falcata* had significantly fewer sporelings and premature individuals and more mature individuals than expected and that the peak of gametophyte establishment and vegetative growth was in April. On the South-Palawai drainage, *D. falcata* occurred in small groups and various life stages, however, premature stages formed about 60 percent of the population (Aguraiuja 2001, Aguraiuja et. al. 2004). *Diellia falcata* hybridizes with *D. unisora* to form an endemic hybrid *D. lauii* which was described as locally common when found by J. Lau in 1991.

Threats to the Species *Diellia falcata* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Greenhouse thrips (*Heliothrips haemorrhoidalis*) have been observed on these plants and in one case approximately 10 percent of the population were damaged (Aguraiuja 2001).

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Diellia falcata* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *D. falcata is* not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua action area or on Oahu (Service 2003a).

Ongoing Conservation Actions No information is available on conservation management for *Diellia falcata* since it was listed as endangered. However, about approximately 1,338 individuals (20 percent) of this species occur in Kahanahaiki Management Unit where they benefit from population unit and/or ecosystem-level protection such as ungulate fencing. *Diellia falcata* is represented in an *ex situ* collection of spores in micropropagation (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 600 ha (1,483 ac) of critical habitat has been designated for *Diellia falcata* in four separate units on Oahu. Critical habitat was designated on State (Pahole Natural Area Reserve and Mokuleia Forest Reserve), Federal (Lualualei Naval Reservation), and private (Honouliuli Preserve) lands. Two of the critical habitat units provide habitat for one population each, one unit provides habitat for three populations, and one unit provides habitat for four populations, each with at least 300 mature, reproducing individuals of *D. falcata* (68 FR 35950).

The primary constituent elements for these units include deep shade or open understory on moderate to moderately steep slopes and gulch bottoms in diverse mesic forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* sp., *Asplenium kaulfussii*, *Carex meyenii*, *Charpentiera* sp., *Claoxylon sandwicense*, *Coprosma foliosa*, *Diospyros hillebrandii*, *D. sandwicensis*, *Diplazium sandwichianum*, *Doodia kunthiana*, *Dryopteris unidentata*, *Elaeocarpus bifidus*, *Freycinetia arborea*, *Hedyotis terminalis*, *Hibiscus* sp., *Melicope* sp., *Metrosideros polymorpha*, *Myrsine lanaiensis*, *Nephrolepis exaltata*, *Nestegis* *sandwicensis*, *Nothocestrum* sp., *Pipturus* sp., *Pisonia sandwicensis*, *Pouteria sandwicensis*, *Psychotria* sp., *Psydrax odorata*, *Sapindus oahuensis*, *Selaginella arbuscula*, *Sophora chrysophylla*, or *Xylosma* sp. and elevations between 394 and 932 m (1,292 and 3,057 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 20 percent of all known individuals of *Diellia falcata* are located within the action area, in the three population units (approximately 1,338 individuals). With 230 mature individuals, the Ohikilolo occurrence is the only occurrence to exceed the minimum threshold of fifty mature reproducing individuals, as required for stabilization populations for this species. This occurrence is protected by an ungulate fence and naturally protected by the topography (cliff faces) in which it thrives; the other 148 individuals in the action area are not fenced, and none of the action area occurrences are actively managed by the Army. *Diellia falcata* plants in the action are in the very low fire risk zones.

Status of the Critical Habitat in the Action Area Two percent (13.7 ha; 33.8 ac) of the critical habitat for *Diellia falcata* is located partially within the Makua action area. This critical habitat unit is located in the eastern portion of the action are, entirely within the very low fire risk zone. This critical habitat unit provides habitat for the conservation of one population of at least 300 mature, reproducing individuals of *D. falcata*. It is estimated that more than 80 percent of the critical habitat within the Makua action area for this species has a native plant component of more than 50 percent (U.S. Army Garrison 1999a; K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Diellia falcata* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Thus, *D. falcata* has a moderate background risk of species extinction, and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area No conservation actions are currently being implemented for *Diellia falcata* in the action area. However, this species benefits from ecosystem-level management in the fenced Kahanahaiki and Ohikilolo Management Units, where non-native ungulates and weeds are controlled. In addition, fuels modification along the Kaluakauila ridgeline reduces the risk of fire in the management unit (K. Kawelo, pers. comm. 2004; Service 2004).

Status of the Species – *Dubautia herbstobatae* (Naenae)

Species Description *Dubautia herbstobatae* is a shrub that can be either upright or sprawling, has stems reaching to 0.5 m (1.6 ft) in length, and is a member of the Asteraceae (sunflower) family. Its leaves are opposite, or rarely ternate (three per node), and measure 2 to 5.5 cm (0.8 to 2.1 in) long. The inflorescences are borne on the stem tips and contain 5 to 15 yellowish-orange flower heads. The flower heads contain 4 to 20 disk florets and lack ray florets. The achenes (a type of dry, seed-like fruit) are 4 to 6 mm (0.157 to 0.236 in) long and are tipped by feather-like bristles (Wagner et al 1999).

Listing Status *Dubautia herbstobatae* was federally listed as endangered on October 29, 1991, and State listed as endangered in Hawaii at the same time (61 FR 53108). A recovery plan was prepared for this species in August 1995 and August 1998 (Service 1995a, 1998a). Critical habitat was designated for this species on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Dubautia herbstobatae* is endemic to the Hawaiian Islands and is known to occur on the leeward side of the northern Waianae Mountains on only two ridge systems. These ridge systems span a distance of approximately 6 km (4 mi). One system includes Ohikilolo Ridge and the ridges in and around Keaau Valley. The second ridge system includes Kamaileunu, encompassing the Kamaileunu and Waianae Kai population units. This species appears to be increasing. Currently, there are approximately 1,188 individuals in the Keaau (70 mature plants), Makaha/Ohikilolo (350 mature plants), Ohikilolo/Makai (358 mature plants), Ohikilolo/Mauka (382 mature and six immature plants), Makaha (36 mature and one immature plant), and Waianae Kai (10 mature and four immature plants) population units (Table SB 15) (U.S. Army Garrison 2005c). On Oahu, demographic data shows that about 99 percent of total *D. herbstobatae* individuals are mature plants, and one percent are immature augmentations. Thus, *D. herbstobatae* is characterized by three populations each with more than 50 mature, reproducing individuals (the recommended number for stabilization populations for this species; Service 1995a, 1998a) in the action area and four populations outside of the action area each with fewer than 50 mature reproducing individuals.

Table SB 15. Range-wide Distribution of *Dubautia herbstobatae.*

Population Units	**Number of Known Individuals**							
	1991 (1)	**1995 (2)**	**1998 (3)**	**2003 (4)**	**2004 (5)**	**2004 (6)**	**2005 (7)**	**2006 (8)**
Keaau	--	--	--	--	70-120	70	70	70/0
Ohikilolo/ Makaha	--	--	--	--	--	--	350	350/0
Ohikilolo/ Makai*	--	--	--	--	700	357	357	358/0
Ohikilolo Mauka*	--	--	--	--	1,300	267/20‡	328/20	382/6
Kamaileunu	--	--	--	--	1	0	0	0/0

Makaha*	--	--	--	--	--	0	36/1	36/1
Waianae Kai	--	--	--	--	5	5	10/4	10/4
Total Individuals on Oahu	**<100**	**3,000-4,000**	**525**	**<100**	**2,076-2,126**	**719** (699/20)†	**1,176** (1,151/25)	**1,188** (1,177/11)

Shaded population units are inside the action area.
Numbers include total mature/immature individuals.
*Stabilization Population Units
‡Mature/immature individuals
†Total (mature/immature)

(1) Listing rule (61 FR 53108)
(2) Recovery plan (Service 1995a)
(3) Recovery plan (Service 1998a), Oahu Biological Opinion (Service 2003a)
(4) Critical habitat rule (68 FR 35950)
(5) MIP (Makua Implementation Team 2003)
(6) MIP Addendum and 2004 status update (U.S. Army Garrison 2005a, 2004)
(7) 2005 status update (U.S. Army Garrison 2005b)
(8) 2006 status update (U.S. Army Garrison 2006c)

<u>Ecology</u> *Dubautia herbstobatae* occurs in dry-mesic to mesic areas and is often found on open rocky slopes and cliff faces. These slopes and cliffs are usually more or less north-facing. The vegetation of these habitats is rather sparse shrublands and scrubby forests. Flowering usually occurs in May and June. The species is almost certainly pollinated by insects, as are most other yellow-flowered members of the sunflower family, along with those *Dubautia* species whose mode of pollination has been studied. The breeding system of *D. herbstobatae* has not been studied. However, with respect to other members of this genus whose breeding systems have been studied, some are obligate out-crossers, and others are capable of self-pollination (U.S. Army Garrison 2003b). Other demographic information for *D. herbstobatae* in the wild is unknown.

<u>Threats to the Species</u> *Dubautia herbstobatae* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described under the "General Status and Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. (U.S. Army Garrison 2003b; Service 2003b; 68 FR 35950). *Dubautia herbstobatae* are vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (61 FR 53108; Service 1995a, 1998a). Thus, *D. herbstobatae* has a high background risk of extinction, and any additional threats would eliminate expectation of its long-term persistence.

<u>Conservation Needs of the Species</u> Conservation actions that should be implemented for the recovery of *Dubautia herbstobatae* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain stability for long-lived individuals. The recovery plan for this species identifies the following important conservation actions. The types of management actions needed at these occurrences will depend on local site characteristics but should include

fencing, ungulate control, protection from fire, weed control, maintenance of adequate genetic stock, and outplanting of local genetic material (Service 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Dubautia herbstobatae* which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). *Dubautia herbstobatae* can be successfully propagated from seed, air layers and cuttings. It is represented in several *ex situ* collections including: 23 cuttings in nurseries (Army Environmental Division, Oahu and Harold L. Lyon Arboretum), 3,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and six seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b). Feral ungulate control is being implemented by the Army and State in Makua (U.S. Army Garrison 2005b).

Critical Habitat Description A total of 91 ha (226 ac) of critical habitat was designated for *Dubautia herbstobatae* in three separate units on the island of Oahu. Two of the units provide habitat for one population each and one critical habitat unit provides habitat for two populations, each to have a minimum of 100 mature, reproducing individuals of *D. herbstobatae* (68 FR 35950). The primary constituent elements for these units include rock outcrops, ridges, moderate slopes, or vertical cliffs in dry or mesic shrubland containing one or more of the following associated native plant species: *Artemisia australis*, *Bidens torta*, *Carex meyenii*, *Chamaesyce celastroides*, *Dodonaea viscosa*, *Eragrostis variabilis*, *Metrosideros polymorpha*, or *Schiedea mannii*; and elevations between 473 and 975 m (1,551 and 3,198 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat See introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. The primary threats to *Dubautia herbstobatae* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Approximately 98 percent of all individuals of *Dubautia herbstobatae* are within the action area in the Keaau, Makaha/Ohikilolo, Makai/Ohikilolo, and Makua/Ohikilolo population units. These four population units are being managed for stability. All four population units are at risk from training-related wildfire, but all individuals of *D. herbstobatae* are located in the low and very low fire risk zones. Approximately 55 percent of the *D. herbstobatae* individuals located in the action area are in fenced locations and will benefit from ungulate exclusion. It is difficult to discern an overall trend in the abundance of this species as its numbers have varied greatly in the last decade.

Status of the Critical Habitat in the Action Area Sixteen percent or 14 ha (36 ac) of the designated State-wide critical habitat is located within the Makua action area, in portions of two critical habitat units. These units constitute 16 percent of both the species' State-wide and Oahu-wide designated critical habitat. The two units are located in the south-central portion of the action area and are located in the low fire risk zone. These critical habitat units provide habitat for the conservation of three populations, each comprised of a minimum of 100 mature, reproducing individuals of *Dubautia herbstobatae*. It is estimated that the majority of the critical habitat is in forest habitat with greater than 25 percent native plant cover (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat The primary threats to *Dubautia herbstobatae* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Approximately 800 mature and five immature naturally occurring *Dubautia herbstobatae* plants are growing in the low fire risk zone where they may be burned by an Army-caused fire, 350 mature plants occur in the very low fire risk zone within the Makua action area where fire impacts are less likely.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Dubautia herbstobatae* because no populations with more than 50 mature reproducing individuals exist outside the action area. Four population units have been identified for stabilization measures. Stabilization measures include: collection and propagation of this taxon for genetic storage and reintroduction into the wild, monitoring and management of known population units as identified in the Makua Implementation Plan, and ungulate and non-native plant control (U.S. Army Garrison 2005c).

Ongoing Conservation Actions for the Species and Critical Habitat within the Action Area The Ohikilolo Mauka, Makai and Makaha population units, which contains roughly 90 percent of the total known individuals of *Dubautia herbstobatae* on Oahu, are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Roughly, eight percent (7.1 ha; 17.7 ac) of the critical habitat located in the action area is in a designated management unit (Ohikilolo Management Unit). The plants and habitat located on the Makua Valley side of Ohikilolo are protected by a fence, and the Army is controlling non-native plants (L. Durand, pers. comm. 2004; K. Kawelo, pers. comm. 2004; U.S. Army Garrison 2005c). Since 1995, approximately 1,500 goats have been removed from Makua, and currently no goat sign can be found. Cuttings and seeds have been collected from the Makaha population unit although much of the fruit was not viable. Some genetic collection of *D. herbstobatae* has taken place; however, the collection is not complete (L. Durand, pers. comm. 2004; K. Kawelo, pers. comm. 2004). Genetic storage goals for *D. herbstobatae* are less than one percent completed (13/350).

Status of the Species and Critical Habitat – *Euphorbia haeleeleana* (Akoko)

Species Description *Euphorbia haeleeleana*, a member of the spurge family (Euphorbiaceae), is a dioecious tree 3 to 14 m (10 to 46 ft) tall. The alternate leaves are papery in texture, elliptic, and usually 10 to 15 cm (4 to 6 in) long and 4 to 6-cm (2 in) wide. Male trees bear many small male flowers within a cyathium. The female trees have cyathia with a single female flower surrounded by numerous abortive male flowers. The capsules are round. This species is distinguished from others in the genus in that it is a tree, whereas most of the other species are herbs or shrubs, as well as by the large leaves with prominent veins (Wagner et al 1999; Service 1999b).

Listing Status *Euphorbia haeleeleana* was federally listed as endangered on October 10, 1996 (61 FR 53108), and was State listed as endangered at the same time. A recovery plan for multi-island plants included this species (Service 1999a), and critical habitat was designated on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Euphorbia haeleeleana* is known historically and currently from 15 populations (between 450 and 625 individuals) from northwestern Kauai and the Waianae Mountains of Oahu (Service 1995a, 1995b, 1999a). On Kauai, 11 populations of approximately 360 to 510 individuals are known from valley slopes and cliffs along Kauai's northwestern coast from Pohakuao to Haeleele Valley and Hipalau Valley within Waimea Canyon. All of the Kauai populations occur on State land, including Kauia Natural Area Reserve and the Na Pali Coast State Park (Service 1995b; S. Perlman, pers. comm. 1996). On Oahu, two populations of approximately 90 to 115 individuals are known from the northern Waianae Mountains. One population of 79 individuals occurs at Keawaula in Makua, and one population occurs on privately owned land (B. Totten, pers. comm. 1998; Service 1995a). On Oahu, this deciduous tree occurs in dry forests that are under severe threat of wildfires. There are five population of *E. haeleeleana* with more than 25 mature, reproducing individuals (the minimum number suggested in the recovery plan for this species (Service 1999a). Four of these populations are found outside the Makua action area; therefore, the Army is not responsible for stabilizing this species (Table SB 16).

Table SB 16. Range-wide Distribution of *Euphorbia haeleeleana.*

Population Units	**Number of Known Individuals**					
	1996 (1)	**1999 (2)**	**1999 (3)**	**2003 (4)**	**2005 (5)**	**2006 (6)**
Keawaula	--	79	--	--	1	21/6‡
Kaluakauila	--	--	80	--	200	193/6
Kahanahaiki						34
Palikea Gulch to Kaumokunui	--	--	--	--	~350	--
Total Population Units on Oahu	4	2	4	8	5	8
Total Individuals Oahu	--	**≅ 200**	**90-115**	**134**	--	**226** (214/12)†
Total Individuals on Other Islands					360-510	
Total Population Units	15	15	15	--	--	--
Total Individuals	**450-625**	**450-625**	**450-625**	**--**	**810-1135**	--

Shaded occurrences are inside the action area.
‡Mature/immature individuals
†Total (mature/immature)

(1) Listing rule (61 FR 53108), recovery plan (Service 1999a)
(2) Recovery Plan for Multi-Island Plants (Service 1999a)
(3) Makua Biological Opinion (Service 1999b)
(4) Critical habitat rule (68 FR 35950)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) U.S. Army Garrison 2006d

Ecology Individual trees of *Euphorbia haeleeleana* bare only male or female flowers, and must be cross-pollinated from a different tree to produce viable seed (Wagner et al 1990). This species sets fruit between August and October. Little else is known about the life history of this species. Reproductive cycles, longevity, specific environmental requirements, and limiting factors are unknown. *Euphorbia haeleeleana* is usually found in lowland mixed mesic or dry forest that is often dominated by ohia, ohia and koa, lama, or kukui. The plant is typically found at elevations between 205 and 670 m (680 and 2,200 ft), but a few populations have been found up to 870 m (2,860 ft). Associated plants include aalii, wiliwili, halapepe, ohe, and aulu (Service 1999a).

Threats to the Species *Euphorbia haeleeleana* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Euphorbia haeleeleana* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *E. haeleeleana* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua and Schofield Barracks action areas (Service 2003a).

Ongoing Conservation Actions No specific information is available on conservation management for *Euphorbia haeleeleana* since it was listed as endangered. However, about 200 individuals (30 percent of all remaining individuals) of this species occur in the Kaluakauila Management Unit where they will benefit from population unit and/or ecosystem-level protection. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any *E. haeleeleana* within the preserve. This species is represented in *ex situ* collections that include 13 embryos in micropropagation (Harold L. Lyon Arboretum), five plants in a nursery (Harold L. Lyon Arboretum), 10 plants in a botanical garden (Waimea Valley Audubon Center), and 17 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) (Service 2005b, U.S. Army Garrison 2005d).

Critical Habitat Description Critical habitat was designated for this species on Kauai on February 27, 2003, and on Oahu on June 17, 2003. A total of 1,020 ha (2,522 ac) in five separate units has been designated for *Euphorbia haeleeleana*. Three units located on Kauai include 659 ha (1,630 ac), and two on Oahu total 370 ha (919 ac). Each unit on Kauai will provide habitat for two populations, one unit on Oahu provides habitat for one population, and the other Oahu unit provides habitat for three populations of *E. haeleeleana*. Each population will have a minimum of 300 mature, reproducing individuals (68 FR 9116; 68 FR 35950).

The primary constituent elements for this species include dry forest dominated by *Diospyros* sp. and containing one or more of the following associated native plant species: *Dodonaea viscosa, Erythrina sandwicensis, Pleomele* sp., *Psydrax odorata, Reynoldsia sandwicensis*, or *Sapindus oahuensis*; and elevations between 156 and 526 m (512 and 1,725 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

<u>Threats to the Critical Habitat</u> See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

<u>Status of the Species in the Action Area</u> The three occurrences of *Euphorbia haeleeleana* in the action area total about 230 individuals, or about 40 percent of the species' range-wide total (U.S. Army Garrison 2006c) (see Table SB 16). Only one occurrence (Kaluakauila) has more than 25 mature reproducing individuals. This occurrence is within a fenced ungulate exclosure. Elsewhere in the action area, there is one mature individual in the Keawaula population unit and 34 reintroduced individuals in the Kahanahaiki Management Unit; neither management unit is fenced. *Euphorbia haeleeleana* plants in the action area are located in areas at risk from training-related wildfire. About 199 individuals occur in the high fire risk zone and 35 occur in the low fire risk zone. The individuals in high fire risk zones represent about 25 percent of the species' total range-wide number of mature individuals. Thus, *E. haeleeleana* in the action area is characterized by one occurrence that harbors more than 25 mature reproducing individuals that comprises 25 percent of all remaining individuals, all of which are located within the high to low risk fire zones, and by two occurrences with low numbers and unknown trends.

<u>Status of the Critical Habitat in the Action Area</u> The action area contains a total of 15 ha (37 ac) or four percent of the total critical habitat for *Euphorbia haeleeleana* on the island of Oahu or one percent of the critical habitat for *E. haeleeleana* State-wide. Designated critical habitat is located within one unit in the northwestern portion of the action area. About one percent of critical habitat for this species is located in an area at risk from training-related wildfire. Approximately 15 ha (37 ac) are in the high fire risk zone. It is estimated that the critical habitat is located in an area with up to 75 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Euphorbia haeleeleana* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E.

Conservation Needs of the Species and Critical Habitat in the Action Area   Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area   No conservation actions are currently being implemented for *Euphorbia haeleeleana* in the action area. However, this species benefits from ecosystem-level management in the fenced Kaluakauila Management Unit where non-native ungulates and weeds are controlled.

Status of the Species and Critical Habitat – *Flueggea neowawraea* (Mēhamehame)

Species Description   *Flueggea neowawraea* is a long-lived perennial in the Euphorbiaceae (spurge) family. It is a large dioecious tree (with male and female reproductive parts on separate plants) that can grow to heights of 30 m (100 ft). This species has white oblong pores in its scaly, pale brown bark. The alternately arranged leaves are 4 to14 cm (1.6 to 5.5 in) long. The tiny, greenish flowers are borne in axillary clusters. The round, reddish brown or black fruits are 3 to 6 mm (0.12 to 0.24 in) in diameter and contain six seeds. *Flueggea neowawraea* is the only member of this genus found in Hawaii and can be distinguished from similar Hawaiian species in the family by the hairless, whitish lower leaf surfaces and round fruits (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status   *Flueggea neowawraea* was federally listed as endangered on November 10, 1994 (59 FR 56333), and was State listed as endangered at the same time. This species was included in the recovery plan for multi-island plants (Service 1999a). Critical habitat was designated for *F. neowawraea* on Oahu June 17, 2003 (68 FR 35950), on Kauai on February 27, 2003 (68 FR 9115), on Maui on May 14, 2003 (68 FR 25934), and on Hawaii on July 2, 2003 (68 FR 39624).

Historic and Current Distribution   *Flueggea neowawraea* is a species endemic to the Hawaiian Islands and historically occurred on Oahu, Kauai, Maui, Molokai, and Hawaii.. The recorded history of *F. neowawraea* is relatively short for a native Hawaiian tree, as it was not discovered until 1912. Observations of living and dead trees indicate this species may have been fairly common in some sites, albeit declining in numbers and health. Since its discovery, many large, mature trees were reported with long-dead branches, and no young or immature trees were noted. Currently, *F. neowawraea* still exists throughout its recorded range except on Molokai, where the single known tree died before 1939. Only two trees are known to persist on the southern flank of Haleakala, East Maui. Five to seven trees are known on the island of Hawaii. On Oahu, *F. neowawraea* grows in gulches of the northern Waianae Mountains (Makua Implementation Team 2003). When this species was listed in 1994, there were about 28 occurrences totaling 145 to 162 individuals State-wide, including 15 occurrences totaling 33 individuals on Oahu (59 FR 56333). Trends in numbers indicate a decline since listing to between 132 and 139 currently known individuals at 49 sites State-wide (Service 2004b), including 98 individuals in 10 population units on Oahu (Table SB 17). In addition, there are 60 to 80 trees known on Kauai (Makua Implementation Team 2003).

About 60 percent of the total State-wide *Flueggea neowawraea* individuals are located on Oahu, on Federal, State, city/county, and private lands (U.S. Army Garrison 2005b). Three of the Oahu population units consist of single trees, and all Oahu population units contain fewer than 10 naturally occurring, widely scattered individuals (U.S. Army Garrison 2005b). Apart from augmentations, all increases in numbers on Oahu are due to discovery of seven new individuals, at Makaha (2), West Makaleha (2), Central and East Makaleha (2), and Mt. Kaala Natural Area Reserve (1). None of the currently known population units or occurrences has met minimum numerical criteria for a stabilization population unit (defined as 50 mature, reproducing individuals per population unit). This species is threatened by military-related wildfire in action areas for Makua, Schofield Barracks Military Reservation, and Lualualei Naval Magazine.

On Oahu, trends in reproduction indicate that about 40 percent of *Flueggea neowawraea* individuals are mature plants, and 60 percent are immature augmentations. All naturally occurring individuals are mature trees, and no naturally occurring juveniles or seedlings have been observed. *Flueggea neowawraea* may not be reproducing due to a combination of threats and reproductive challenges (U.S. Army Garrison 2005b). Few trees have been observed in flower or fruit; individual trees are usually isolated and far from trees of the opposite gender, and most are unhealthy due to black twig borer damage. Viable seed has been collected from only two trees, both located in the West Makaleha population unit, the only location where male and female trees are near each other. Thus, *F. neowawraea* is characterized by four stabilization population units in the action area, with less than 50 individuals (not reaching minimum numeric criteria) on Oahu. These individuals represent about 61 percent of all State-wide known individuals. Recent increased numbers on Oahu are due to discovery of new individuals and augmentations from greenhouse-propagated stock, however overall numbers have been declining State-wide since listing.

Table SB 17. Range-wide Distribution of *Flueggea neowawraea*.

Population Units	**Number of Known Individuals**					
	1994 (1)	**1999** (3)	**2003** (4)	**2004** (5)	**2005** (6)	**2006** (6)
Kahanahaiki to Kapuna*	--	--	6	8/0‡ [0/26]§	7/0 [0/42]	7/0 [0/59]
Ohikilolo	--	--	3	2/0	2/0	1/0
West Makaleha	--	--	3	3/0	5/0	6/0
Central & E Makaleha*	--	--	6	6/0	6/0	6/0
Halona	--	--	2	2/0	2/0	2/0
Kauhiuhi	--	--	1	1/1	1/0	1/0
Mikilua	--	--	1	0	1/0	1/0
Mohiakea (SBMR)	--	--	1	0	0	0
Mt. Kaala Natural Area Reserve (SBMR)	--	--	4	4/0	4/0	4/0
Nanakuli	--	--	1	1/0	1/0	1/0
N Kaluaa	--	--	1	0	0	0
N W Makaleha	--	--	1	0	0	0
Makaha*	--	--	5	8/0	9/0	10/0

Waianae Kai	--	--		0	0	0
Other *ex/inter situ* on Oahu						0/30
Total Population Units on Oahu	15	19	13	9	10	10
Total Individuals on Oahu	**33**	**28-30**	**35**	**61** (34/1)† [0/26]	**80** (38/0) [0/42]	**128** (39/30) [0/59]
Total Population Units State-wide	28	34	22	49	49	--
Total Individuals State-wide	**145-162**	**124-195**	**100-124**	**132-139**	**132-139**	--

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (59 FR 56333)
(2) Recovery Plan (Service 1999a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum (U.S. Army Garrison 2005a), Service 2004b
(5) 2005 status report (U.S. Army Garrison 2005b), Service 2004b
(6) 2006 status report (U.S. Army Garrison 2006c, 2006d)

Ecology *Flueggea neowawraea* typically grows in gulch bottoms or on north-facing lower to mid-gulch slopes in the drier parts of mesic forests dominated by *Diospyros sandwicensis* and/or *Metrosideros polymorpha*, at elevations of 305 to 732 m (1,000 to 2,400 ft). *Flueggea neowawraea* was formerly more common in the dry forest than today, as evidenced by numerous old logs and standing dead trunks; only a few live trees remain in dry forests. Where they are found, *F. neowawraea* are often the most massive trees in the forest. Many of the remaining live trees are partially dead, with crowns that have died back but retained some relatively healthy live branches. The wood is very hard and lasts a long time after the death of the tree, and decayed trunks and limbs can be readily identified. The former occurrence of *F. neowawraea* throughout the Waianae Mountains is documented by old, downed logs and pieces of wood in gulch bottoms and streambeds (Makua Implementation Team 2003).

Flowering of *Flueggea neowawraea* occurs over a brief period in the late summer and fall, depending on local rainfall patterns, and is usually well synchronized among the trees in a given area. The small, inconspicuous flowers are presumably pollinated by insects, and the juicy fruits may be dispersed by fruit-eating birds. *Flueggea neowawraea* apparently is not completely dioecious, as a cultivated plant isolated from others has produced viable seeds. Little is known of this species' growth rate and age of maturation in the wild, but it grows rapidly and matures early in cultivation (within three years) (Makua Implementation Team 2003). Other demographic information for *F. neowawraea* in the wild is unknown, including longevity, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements.

Threats to the Species *Flueggea neowawraea* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The primary threat to the continued existence of *F. neowawraea* is the black twig borer, which has affected the vigor of all known individuals by causing slight to severe defoliation. The Chinese rose beetle also causes partial defoliation in *F. neowawraea*. Defoliation together with other stresses, compounded by senescence, could result in death of the entire tree (Makua Implementation Team 2003).

Occurrences of *Flueggea neowawraea* are vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 56333; 68 FR 35950; Service 1999b). Mature individuals of this species are senescent and little or no reproduction occurs in the wild. The need for cross-pollination further constrains this species' recovery, given its low numbers, isolation of mature trees, and separation of male and female trees (Makua Implementation Team 2003). Reductions in population size and reproduction could result in expression of inbreeding depression among any progeny that result, for example, in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *F. neowawraea* already is in a phase of "quasi-extinction," with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *F. neowawraea* has a high background risk of species extinction and any additional threats would eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Flueggea neowawraea* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). At least 50 mature, reproducing individuals are needed per population unit to attain minimum numerical criteria for a stabilization population unit for long-lived perennials. However, *F. neowawraea* requires a stabilization target of at least 50 mature individuals for each population unit due to its lack of reproduction in the wild, dioecious nature, senescence of mature individuals, and major pest problems (Makua Implementation Team 2003). Little habitat management has been done for this species, and most trees are found in degraded, unprotected habitats (U.S. Army Garrison 2005b). The most critical need for this species is research to develop feasible control techniques for the black twig borer that do not also impact native scolytid beetles. In addition, only five mature trees are protected by existing fence exclosures; all remaining trees should be fenced to protect them from damage and habitat degradation due to feral ungulate activity. Population units must be augmented and new occurrences must be reintroduced within the historic range of *F. neowawraea*. To accomplish this, propagation methods must be developed and implemented with material collected from as many *F. neowawraea* individuals as possible, and flowers from isolated male and female trees must be cross-pollinated by hand to produce viable seed.

<u>Ongoing Conservation Actions</u> The Makua Implementation Team (2003) has developed stabilization protocols for *Flueggea neowawraea*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Kahanahaiki to Kapuna and Ohikilolo population units are within fenced or partially fenced management units. In addition, occurrences within some population units are located in five management units (Upper Kapuna, West Makaleha, East Makaleha, Manuwai, and Makaha) where they will benefit from ecosystem-level protection after these management units are fenced in the future. Black twig borer control is being studied by the non-profit Hawaii Agricultural Research Center (funded by the Hawaii Invasive Species Council). Some *F. neowawraea* plants are being grown in *ex situ* collections at the Army Environmental Greenhouse on Oahu (11 plants), the Nanakuli reintroduction site (10), Leeward Community College (5), and Waimea Audubon Center (14) (U.S. Army Garrison 2005b).

Flueggea neowawraea can be successfully propagated from seed, air layers, and cuttings, although the process may be slow and success relatively low (U.S. Army Garrison 2005b). One tree in the West Makaleha population unit produced many fruit in 2001 with viable seed, and additional seed can be collected from greenhouse specimens as they mature. Micropropagation has not been successful. Greenhouse propagation and production of air layers are also affected by the black twig borer. *Flueggea neowawraea* is represented in several *ex situ* collections, including eight air layers in a nursery (Army Environmental Division, Oahu), five vegetative buds in micropropagation (Harold L. Lyon Arboretum), 186 cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), eight leaf tissues in micropropagation (Harold L. Lyon Arboretum), 84 plants in a nursery (Volcano Rare Plant Facility), 11 plants in a botanical garden (Waimea Valley Audubon Center), 495 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 100 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and one seedling in a nursery (Harold L. Lyon Arboretum) (Service 2005b; U.S. Army Garrison 2005d).

<u>Critical Habitat Description</u> A total of 2,926 ha (7,230 ac) of critical habitat for *Flueggea neowawraea* was designated in 10 separate units on five islands. On Oahu, a total of 845 ha (2,087 ac) was designated in one unit on State lands (Mokuleia Forest Reserve, and Pahole and Mt. Kaala Natural Area Reserves) to provide habitat for one population of 100 mature, reproductive individuals. On Kauai, a total of 595 ha (1,471 ac) in six units was designated to provide habitat for one population each, on State lands (Alakai Wilderness Preserve, Kuia and Hono o Na Pali Natural Area Reserves, and Na Pali Coast State Park). On Molokai, a total of 61 ha (151 ac) was designated in one unit to provide habitat for one population on State land (Molokai Forest Reserve). On Maui, two units totaling 102 ha (252 ac) were designated on State lands, which in combination with non-designated private land, provide habitat for one population. On Hawaii, a total of 1,475 ha (3,645 ac) was designated in two units to provide habitat for one population each, on State land (South Kona Forest Reserve and Manuka Natural Area Reserve) and private land. To meet recovery goals, a population should be represented by at least 100 mature, reproducing individuals of *F. neowawraea* (68 FR 9116; 68 FR 12982; 68 FR 25934; 68 FR 35950).

The primary constituent elements of critical habitat on Oahu include gulch slopes and ridge crests near streams in dry or mesic forest at elevations between 335 to 1,006 m (1,099 to 3,300 ft). In addition, critical habitat contains one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma platyphyllum*, *A. pulvinatum*, *Bobea* sp., *Chamaesyce herbstii*, *C. multiformis*, *Charpentiera* sp., *Claoxylon sandwicense*, *Diospyros hillebrandii*, *D. sandwicensis*, *Erythrina sandwicensis*, *Hedyotis terminalis*, *Hibiscus arnottianus*, *Metrosideros polymorpha*, *Morinda trimera*, *Myoporum sandwicense*, *Myrsine* sp., *Nestegis sandwicensis*, *Pipturus albidus*, *Pisonia sandwicensis*, *P. umbellifera*, *Pittosporum* sp., *Pleomele* sp., *Psydrax odorata*, *Pteralyxia* sp., *Rauvolfia sandwicensis*, *Sapindus oahuensis*, or *Streblus pendulinus*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation.

<u>Threats to the Critical Habitat</u> See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

<u>Status of the Species in the Action Area</u> About 57 percent of all known individuals of *Flueggea neowawraea* on Oahu, and 42 percent of total individuals State-wide, are located within the action area in three population units: Kahanahaiki to Kapuna, Ohikilolo, and West Makaleha (see table above). About 37 percent of the mature individuals on Oahu are located within the action area. Recent survey data indicate an overall increase of 39 to 73 *F. neowawraea* individuals in the action area since 2003, due to augmentation of immature plants and discovery of new mature individuals in the wild. During this time period, the number of naturally occurring mature trees declined from eight to seven in the Kahanahaiki to Kapuna population unit, increased from three to six due to new discoveries in the West Makaleha population unit, and decreased from two individuals to one in the Ohikilolo population unit. Trends in reproduction indicate 37 percent of the total individuals in the action area are mature and 63 percent are immature augmentations.

Flueggea neowawraea in the action area are located in areas at risk from training-related wildfire. Approximately 64 individuals are located in the low fire risk zone and nine individuals occur in the very low fire risk zone. These individuals represent about 57 percent of the species' population density on Oahu. Thus, *F. neowawraea* in the action area is characterized by three stabilization population units that currently do not represent numerical stabilization criteria. The number of *F. neowawraea* on Oahu have increased solely due to augmentation and discovery of new individuals

<u>Status of Critical Habitat in the Action Area</u> The action area contains a total of 174 ha (431 ac), or 6 percent, of the total designated critical habitat for *Flueggea neowawraea*. Designated critical habitat is located within seven management units in the northeastern portion of the action area. This critical habitat is a portion of a larger 845 ha (2,087 ac) critical habitat unit that extends outside the action area boundary and provides habitat for three populations of *F. neowawraea*. About six percent of critical habitat for this subspecies is located in an area at risk from training-related wildfire, with small portion located in the high fire risk zone. Approximately 0.2 ha (0.6 ac) are in the high fire risk zone and 174 ha (431 ac) are in the very low fire risk zone. It is estimated that a little over half of the critical habitat is located in forest with more than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Flueggea neowawraea* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Flueggea neowawraea* in the action area is particularly vulnerable to damage from the black twig borer and the Chinese rose beetle, and lack of reproduction due to restricted pollination. About six percent of designated critical habitat for this subspecies is located in an area at risk from training-related wildfire. Thus, because about 42 percent of all known State-wide individuals occur within the action area, *Flueggea neowawraea* in the action area has a high background risk of species extinction, and any additional threats would eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Flueggea neowawraea* because no stabilization population units that meet minimum numerical criteria exist outside the action area. Three population units have been identified for stabilization of *F. neowawraea*: Kahanahaiki to Kapuna in the action area, and Central and East Makaleha, and Makaha outside the action area. In the Kahanahaiki to Kapuna population unit, some trees are not within management unit fences. Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Other general conservation needs of the subspecies and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Kahanahaiki to Kapuna population unit, which contains 66 percent of the total remaining individuals of *Flueggea neowawraea* on Oahu, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located within the Kahanahaiki (subunits I and II), Pahole, and Upper Kapuna Management Units. In the Kahanahaiki to Kapuna population unit, Kahanahaiki subunit II and Pahole Management Units are fenced, the Okikilolo Management Unit is fenced, and one tree outside the Ohikilolo Management Unit fence is protected by a small exclosure. The Army recently planted large *F. neowawraea* saplings in deep soil along a gulch bottom in the Kahanahaiki to Kapuna population unit. It is hoped the outplants will respond to this favorable environment with growth and vigor, and that hand-pruning of branches damaged by the black twig borer will allow the trees to mature and flower. The Army has submitted a research application to U.S. Geological Survey, Biological Resources Division for black twig borer research and is working with the University of Hawaii and the Hawaii Department of Agriculture to support research funding (U.S. Army Garrison 2005b). Genetic storage goals for *F. neowawraea* are less than one percent complete, with only four plants from three population units combined meeting the goals outlined in the Makua Implementation Plan. In addition, there are 11 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Gouania vitifolia* (No Common Name)

Species Description *Gouania vitifolia* is a perennial vine in the Rhamnaceae (buckthorn family). It is a climbing shrub or woody vine with tendrils and elliptic, papery leaves that have toothed or lobed margins. The leaves are 3 to 8 cm (1.2 to 3.2 in) long, with a moderate to dense covering of short soft hairs on both surfaces. Small white flowers are arranged in axillary spikes 0.8 to 7 cm (0.3 to 2.8 in) long. The winged fruits are 9 to 10 mm (0.4 in) long and contain small, dark, glossy seeds (Wagner et al 1999).

Listing Status *Gouania vitifolia* was federally listed as endangered on June 27, 1994 (59 FR 32932), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for this species was designated for Oahu on June 17, 2003 (68 FR 35950); for Hawaii on July 2, 2003 (68 FR 39624); and for Maui on May 14, 2003 (68 FR 25934).

Historic and Current Distribution *Gouania vitifolia* is a species endemic to the Hawaiian Islands. Historic data indicate the species was known from the islands of Oahu, Maui, and Hawaii. On Oahu, *G. vitifolia* historically was known from the northwest Waianae Mountains, in the Makaleha, Keaau, and Waianae Kai valleys (59 FR 32932; 68 FR 35959). When the species was listed in 1994, the only known occurrences were two patches of about eight individuals in the Waianae Kai area of Oahu (59 FR 32932; Service 1998a). Currently, three population units for this species contain approximately 81 individuals state-wide (Table SB 18). The two population units on Oahu total approximately 79 individuals (K. Kawelo, pers. comm. 2005, 2007), and comprise 95 percent of the total state-wide numbers for this species and 98 percent of its numbers on Oahu. All population units are found on State and private lands (68 FR 35950).

Since listing, trends in abundance and distribution indicate an increase in individuals at the Keaau population unit on Oahu, owing almost entirely too increased survey effort. Numbers in the Waianae Kai population unit are very low and have declined since listing. The Keaau population unit appears to have attained the numerical criterion for a stabilization unit, generally defined for perennials as 50 mature, reproducing individuals (Makua Implementation Team 2003). Plants in the Keaau population unit are located in a zone at very low risk from training-related wildfire. On the island of Hawaii, this species appears to have declined from 18 individuals in the mid 1990s to only two known idividuals in 2006. Thus, *Gouania vitifolia* on Oahu comprises about 98 percent of the state-wide population and is characterized by one population unit meeting numerical criterion for stabilization and two population units at very low numbers of individuals.

Table SB 18. Range-wide Distribution *Gouania vitifolia*.

Population Units	Numbers of Known Individuals				
	1994 (1)	**1995-1998** (2)	**2003** (3)	**2005** (4)	**2006** (5)
Keaau*	--	--	45	50	77
Waianae Kai	8	5	1	2-8	2
Total Individuals Oahu	**8**	**8**	**46**	**52-58**	**79**
Manuka (Big Island)	--	18	2	2	2
Total Individuals State-wide	**8**	**26**	**48**	**54-60**	**81**

Shaded population units are inside the action area.
Numbers include total mature/immature individuals.

*Stabilization Population Units

(1) Listing rule (59 FR 32932)
(2) Recovery plans (Service 1995a, 1998a)
(3) Critical habitat rule (68 FR 35950)
(4) K. Kawelo, pers. comm. 2005
(5) K. Kawelo, pers. comm. 2005, 2007

Ecology *Gouania vitifolia* on Oahu occurs on the sides of ridges and gulches in dry to mesic forests at elevations of 39 to 978 m (128 to 3,208 ft) (68 FR 35950). Plants tend to occur in patches, which may consist of clones of a single or few individuals. The main vine produces new young side shoots in winter and spring, which soon die. Flowering has been observed from March to May (68 FR 35950) and from late November to January (Service 1995a), probably in response to rainfall; seed capsules develop in about six to eight weeks. Plants appear to live about 10 to 18 years in the wild, and *are* likely to form large clonal viney mats. Other demographic information for *G. vitifolia* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats to the Species *Gouania vitifolia* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. Population units also are vulnerable to extirpation from naturally occurring events and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 32932; 68 FR 35950; Service 1995a; Service 1998a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *G. vitifolia* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation of one or more populations units or result in the extinction of the species in the wild. Thus, *G. vitifolia* has a very high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Gouania vitifolia* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). In general, at least 50 mature, reproducing individuals are needed in each of at least three population units to meet stabilization targets for short-lived perennials. This goal will require reintroduction and/or augmentation, threat control, and *ex situ* genetic storage to stabilize at least three population units of *G. vitifolia*.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for 27 other plant target taxa in the Makua action area, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Army and the Service are developing a full stabilization plan for *Gouania vitifolia*, which will be reviewed and approved by the Makua Implementation Team. In 2005, State-wide *ex situ* collections for this species included five cuttings in a nursery (Harold L. Lyon Arboretum), nine apical stems in micropropagation (Harold L. Lyon Arboretum), one plant in a botanical garden (Waimea Valley Audubon Center), 18 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), and six seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 2,764 ha (6,830 ac) of critical habitat, in 10 separate units, was designated for *Gouania vitifolia* on the islands of Oahu, Maui, and Hawaii. On Oahu, 559 ha (1,379 ac) of critical habitat was designated in eight units on State lands (including Kaena Point State Park and Kuaokala, Mokuleia, Waianae Kai, and Makua-Keaau Forest Reserves) and on private lands. The eight Oahu units combined provide habitat for seven populations. One 486-ha (1,198-ac) unit providing habitat for one population was designated on State (West Maui Natural Area Reserve) and private lands on Maui. One 1,785-ha (4,412-ac) unit providing habitat for two populations was designated on State land (Manuka Natural Area Reserve) on Hawaii. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals (68 FR 35950).

The primary constituent elements for critical habitat units on Oahu include sides of ridges or gulches in dry to mesic forests at elevations of 50 to 944 m (164 to 3,096 ft). In addition, these units contain one or more of the following associated native plant species: *Bidens* sp., *Carex meyenii*, *Chamaesyce* sp., *Diospyros sandwicensis*, *Dodonaea viscosa*, *Erythrina sandwicensis*, *Hedyotis* sp., *Hibiscus arnottianus*, *Melicope* sp., *Nestegis sandwicensis*, *Pipturus albidus*, *Psychotria* sp., or *Urera glabra*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 98 percent of all known individuals of *Gouania vitifolia* state-wide are located within the action area, in the Keaau population unit (see Table SB 18). The Keaau population unit contains about 97 percent of all known individuals on Oahu, and is located in the very low fire risk zone on private land in the southeastern part of the action area. This population unit appears to have increased since 2003; however, it is unclear whether this increase represents new individuals, new clones, or new discoveries resulting from increased survey effort. No information is available on the relative numbers of mature and immature individuals in this population unit. If 50 mature, reproducing individuals per population unit are determined sufficient for stabilization of this species, then the Keaau population may be considered to exceed numerical targets; however, full stabilization would not be achieved because threats are not controlled and full genetic representation is incomplete. Thus, *G. vitifolia* in the action area comprises 97 percent of the taxon's range-wide total population and is characterized by an increasing number of individuals in one population unit due to new discoveries.

Status of the Critical Habitat in the Action Area The action area contains a total of 84.2 ha (208 ac), or 17 percent, of the total critical habitat designated on Oahu for *Gouania vitifolia*, in parts of four units. Approximately 1.7 ha (4.2 ac) are in the high fire risk zone, 82.3 ha (203.3 ac) are in the low fire risk zone, and 0.2 ha (0.5 ac) are in the very low fire risk zone. State-wide, about three percent of critical habitat for this species on Oahu, Maui, and Hawaii is located in areas at high, low, and very low risks of training-related wildfire in the action area. It is estimated that close to 90 percent of the critical habitat is located in forest with less than 25 percent native plant cover (K. Kawelo, pers. comm., 2004; Service 2004a). None of the critical habitat designated for this species on Oahu is located within Army conservation management units.

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Gouania vitifolia* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. State-wide, the action area critical habitat represents about 3 percent of total critical habitat at risk of training-related fire. However, 97 percent of all known individuals occur within the action area in a zone of very low fire risk from military training. Thus, *G. vitifolia* in the action area has a very high background risk of species extinction and major effort is needed to protect it from existing and additional threats to its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area A full stabilization plan for *Gouania vitifolia* will be developed for incorporation in the Makua Implementation Plan Addendum, and will be reviewed and approved by the Makua Implementation Team. This species will be included in the Implementation Plan because more than 50 percent of the total known individuals occur within the action area and there are no population units with more than two known individuals outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat."

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Army and the Service are developing a draft stabilization plan for *Gouania vitifolia*. General stabilization goals to improve the status of this species include management to attain three stable population units, each with a minimum of at least 50 mature, reproducing individuals (the general criterion for short-lived perennials). The plan will include, at the minimum, management of the two existing *in situ* population units on Oahu. Certain actions, such as baseline surveys and negotiation of cooperative agreements with private landowners for conservation work (including fence and firebreak construction), may begin while the stabilization plan is being developed for approval by the Makua Implementation Team. In addition, a post-fire revegetation plan and site-specific fuels modification are needed for the Keaau population unit. Only about 52.5 ha (129.8 ac) of critical habitat for this species is located within management units both within and outside of the action area (Lower Ohikilolo, Makaha). A negligible amount (less than 0.1 ha (0.1 ac)) of the total critical habitat that is within management units is located inside the action area (Lower Ohikilolo).

Status of the Species and Critical Habitat – *Hedyotis degeneri* var. *degeneri* (No Common Name)

Species Description *Hedyotis degeneri* var. *degeneri* is a short-lived perennial shrub in the Rubiaceae (coffee) family. The long stems sprawl on the ground or are supported by surrounding vegetation. The stems bear short leafy shoots in the leaf axils, and older stems have peeling, corky layers of bark. The oppositely arranged leaves are 1 to 3 cm (0.4 to 1.2 in) long. Inflorescences at the branch tips contain 1 to 10 greenish flowers. Some flowers are perfect (with both male and female reproductive parts) and others possess only female reproductive parts. The round seed capsules split open across the top when mature (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status The species *Hedyotis degeneri* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. The species was included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat was designated for the species on June 17, 2003 (68 FR 35950). *Hedyotis degeneri* is comprised of two varieties, *H. degeneri* var. *degeneri* and the extremely rare or extinct *H. degeneri* var. *coprosmifolia*. Both varieties are included in the listed taxon.

Historic and Current Distribution *Hedyotis degeneri* var. *degeneri* is endemic to the northern Waianae Mountains of Oahu. Records indicate this taxon historically was known from Mt. Kaala in the northern Waianae Mountains, and was found primarily on the windward side of the range. *Hedyotis degeneri* var. *degeneri* in the Kahanahaiki area of Makua are the only ones recorded on the leeward side of the Waianae Mountains. It is estimated only one occurrence of six individuals of *H. degeneri* var. *degeneri* was known when the species was listed in 1991 (56 FR 55770). All except one of the known *H. degeneri* var. *degeneri* population units were discovered in the last eight years, so population trends are not yet evident (Makua Implementation Team 2003). More individuals were discovered in 2003, when there were five occurrences totaling 131-146 individuals. Since 2003 additional individuals have been discovered. Currently, there are 322 known individuals in two population units located on Federal, State, and private lands (Table SB 19) (U.S. Army Garrison 2005b). Two of these population units exceed minimum numerical criteria for stabilization population units (defined as 100 mature, reproducing individuals per population unit).

Trends in reproduction indicate that only about seven percent of all individuals are immature plants. Recruitment has been observed in good habitat of the Kahanahaiki to Pahole population unit, as seedlings become juvenile and then mature plants (U.S. Army Garrison 2005b). Thus, *Hedyotis degeneri* var. *degeneri* is characterized by four population units, one of which exceed minimum numerical criteria for stabilization population unit, and an overall increase in numbers due to discovery of new individuals. Even with the discovery of new individuals this species has a high risk of extinction due to the overall low population numbers and limited range.

Table SB 19. Range-wide Distribution of *Hedyotis degeneri* var. *degeneri*

Population Unit (PU)	**1991 (1)**	**1995-1998 (2)**	**2003 (3)**	**2004 (4)**	**2005 (5)**	**2006 (6)**
*Kahanahaiki	Unk	Unk	11	40/0	279/16	492/16

*Pahole	Unk	25	150			
*Alaiheihe and Manuwai	Unk	Unk	60	60/0	61/2	34/2
*Central Makaleha & W Branch of E Makaleha	Unk	1	47	47	33/10	33/10
E Branch of E Makaleha	Unk	Unk	10	10	13/9	10/0
Kamaileunu	6	6	0	0	0	0
Total PU's	1	3	5	4	386/37	561/44
Total Individuals	6	32	278	157	**= 423**	**= 615**

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (61 FR 53098)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 Status update (U.S. Army Garrison 2005b)
(6) 2006 Status update (U.S. Army Garrison 2006c)

Ecology *Hedyotis degeneri* var. *degeneri* typically grows on upper gulch slopes and on ridge tops between elevations of 570 and 720 m (1,870 to 2,360 ft). It usually occurs in the understory of mesic forests dominated by *Diospyros sandwicensis* and/or *Metrosideros* species. *Hedyotis degeneri* var. *degeneri* also occurs where scrubby forests of the upper gulch slopes grade into shrubland on ridge crests. Flowering and fruiting has been recorded at various times of the year. The flowers are likely to be insect-pollinated, but dispersal agents for the fruits are unknown. The longevity of *H. degeneri* var. *degeneri* individuals is unknown, but it is probably similar to that of other small shrubs that live less than 10 years (Makua Implementation Team 2003). Other demographic information for *H. degeneri* var. *degeneri* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats to the Species *Hedyotis degeneri* var. *degeneri* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. At relatively high numbers, this taxon still needs protection from non-native ungulates and weeds to attain stabilization. Thus, *H. degeneri* var. *degeneri* has a high background risk of species extinction, and intensive management is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Hedyotis degeneri* var. *degeneri* are described in the introduction to the "Status and

Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). At least 100 mature, reproducing individuals are needed per population unit to exceed minimum numerical criteria for stabilization for short-lived perennials (Makua Implementation Team 2003). The Kahanahaiki subunit II portion of the Kahanahaiki to Pahole population unit is not fenced. The East Makaleha and Manuwai Management Units are not fenced; fence construction for these management units is scheduled for 2008 and 2012, respectively. Fencing these management units is needed to benefit East Branch of East Makaleha and part of the Alaiheihe and Manuwai population units, respectively. In addition, surveys to locate *H. degeneri* var. *coprosmifolia* should be conducted. Genetic material should be collected and any remaining individuals protected to determine whether this taxon represents a genetically distinct variety (Service 1998a).

<u>Ongoing Conservation Actions</u> The Makua Implementation Team (2003) has developed stabilization protocols for *Hedyotis degeneri* var. *degeneri*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Kahanahaiki to Pahole population unit is partially fenced and occasionally weeded. In addition, this species is located in occurrences over four management units where it will benefit from population unit and/or ecosystem-level protection: Kahanahaiki (subunit II), Pahole, East Makaleha, and Manuwai.

Hedyotis degeneri var. *degeneri* can be successfully propagated from seed and cuttings. The unpredictable flowering and fruiting of this taxon complicates seed collection. Seed viability varies among population units (26 percent to 81 percent). In some areas, *H. degeneri* var. *degeneri* grows in association with *Hedyotis acuminata* and *Hedyotis schlechtendahliana*, and potentially could hybridize with these species. No outplantings of *H.s degeneri* var. *degeneri* have yet been attempted for this taxon. *Hedyotis degeneri* var. *degeneri* is represented in *ex situ* collections that include 10 cuttings in a nursery (Army Environmental Division, Oahu), 73 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 11,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and five seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b; U.S. Army Garrison 2005d).

<u>Critical Habitat Description</u> A total of 928 ha (2,294 ac) in two separate units on the island of Oahu has been designated for *Hedyotis degeneri* var. *degeneri*. Critical habitat was designated on State land (Mokuleia and Waianae Kai Forest Reserves, and Kaala and Pahole Natural Area Reserves). One of the critical units provides habitat for one population and the other provides habitat for eight populations of 300 mature, reproducing individuals (68 FR 35950). To meet recovery goals, a population should be represented by at least 100 mature, reproducing individuals of *H. degeneri* (68 FR 35950).

The primary constituent elements of critical habitat include ridge crests in diverse mesic forest at elevations between 360 and 1,083 m (1,181 and 3,552 ft). In addition, all units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Carex meyenii*, *Chamaesyce multiformis*, *Cocculus* sp., *Dicranopteris linearis*, *Diospyros sandwicensis*, *Dodonaea viscosa*, *Gahnia* sp., *Hedyotis terminalis*, *Leptecophylla tameiameiae*, *Lysimachia hillebrandii*, *Lobelia yuccoides*, *Metrosideros polymorpha*, *Pleomele* sp., *Psydrax odorata*, *Psychotria hathewayi*, or *Wikstroemia oahuensis*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 53 percent of all known individuals of *Hedyotis degeneri* var. *degeneri* are located within the action area, in the Kahanahaiki to Pahole population unit (see Table SB 19). The recent increase in this population unit since 2003 is due to improved monitoring efforts and discovery of previously unknown plants. Most of the plants occur along the back wall of Pahole Gulch in near pristine habitat. *Hedyotis degeneri* var. *degeneri* plants in the action area are located in areas at risk from training-related wildfire. No individuals occur in the high fire risk zone and 188 individuals in the low fire risk zone. The individuals in fire risk zone represent about 53 percent of the species' total range-wide numbers. So, *Hedyotis degeneri* var. *degeneri* in the action area is characterized by one population unit that exceeds minimum numerical criteria with relatively high numbers of individuals, comprising 53 percent of all remaining plants in the zone with low risk from training-related wildfire.

Status of Critical Habitat in the Action Area The action area contains a total of 212 ha (524 ac) of the total critical habitat for *Hedyotis degeneri* var. *degeneri*. Designated critical habitat is located within one unit in the eastern portion of the action area. This critical habitat is a portion of a larger 705 ha (1741 ac) critical habitat unit that extends outside the action area boundary and provides habitat for four population units of *H. degeneri* var. *degeneri*. About 23 percent of critical habitat for this subspecies is located in an area at risk from training-related wildfire, with less than one percent located in the high fire risk zone. Approximately 0.2 ha (0.6 ac) are in the high fire risk zone, 17 ha (41 ac) are in the low fire risk zone and 195 ha (482 ac) are in the very low fire risk zone. More than 70 percent of all critical habitat for this species is in forest with more than 25 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004b).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Hedyotis degeneri* var. *degeneri* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. About 23 percent of critical habitat for this subspecies is located in an area at risk from training-related wildfire. Thus, because about 53 percent of all known individuals occur within the action area, *H. degeneri* var. *degeneri* in the action area has a high background risk of species extinction, and intensive management is needed to ensure its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Hedyotis degeneri* var. *degeneri* because only two stabilization population units that exceeds minimum numerical criteria exists outside the action area, and no population unit is fully stabilized with respect to threat control and genetic storage. Three population units have been identified for stabilization of *H. degeneri* var. *degeneri*: Kahanahaiki to Pahole within the action area, and Alaiheihe and Manuwai, and Central Makaleha and West Branch of East Makaleha outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Other general conservation needs of the subspecies and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area *Hedyotis degeneri* var. *degeneri*, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals, and about 23 percent of critical habitat designated for this subspecies, are located within the Kahanahaiki (subunit II), Pahole, East Makaleha, and Manuwai Management Units. The Kahanahaiki to Keawapilau population unit is partially fenced and partially controlled for weeds. Genetic storage goals are about 6 percent complete, with 27 plants meeting the goals outlined in the Makua Implementation Plan. In addition, there are 10 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Hedyotis parvula* (No Common Name)

Species Description *Hedyotis parvula* is a short-lived perennial shrub in the Rubiaceae (coffee) family. It is an erect to sprawling perennial shrub with branches 10 to 30 cm (4 to 12 in) long and oppositely arranged leaves 1 to 4 cm (0.4 to 1.6 in) long. Inflorescences are borne at the branch tips. The four-lobed flowers are white and may have purplish pink tips, and are 5 to 6 mm (about 0.2 in) long. The flowers are either perfect (with both male and female reproductive parts) or possess only female reproductive parts. The round seed capsules are 3.3 to 4.0 mm (0.1 to 0.2 in) long, split open across the top upon maturity, and contain small dull brown seeds (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Hedyotis parvula* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was state listed as endangered at the same time. This species was included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat was designated for *H. parvula* on June 17, 2003 (68 FR 35950).

Historic and Current Distribution *Hedyotis parvula* is endemic to the Waianae Mountains of Oahu and has been documented from Makaleha to Nanakuli valleys. Only two occurrences of *H. parvula* were known when the species was listed in 1991 (56 FR 55770). Most of the population units were recently discovered in the last 20 years. One occurrence on Ohikilolo Ridge indicates a major decline from 100 plants when discovered in 1993 to fewer than 20 plants in 2000 (Makua Implementation Team 2003). Overall, the Ohikilolo population unit appears to be increasing in numbers since the early 1990s. Currently, there are 418 known total individuals in two population units located on Federal and State lands (Table SB 20) (U.S. Army Garrison 2005b). Both population units exceed minimum numerical criteria for stabilization population units (defined as 50 mature, reproducing individuals per population unit).

Table SB 20. Range-wide Distribution of *Hedyotis parvula*.

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Number of Known Individuals</th></tr>
<tr><th>1991
(1)</th><th>1995-1998
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Ohikilolo Makai*</td><td>--</td><td rowspan="2">150</td><td>50</td><td rowspan="2">78/12</td><td rowspan="2">79/29</td><td rowspan="2">120/68</td></tr>
<tr><td>Ohikilolo Mauka*</td><td>--</td><td>17</td></tr>
<tr><td>East Makaleha*</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Halona & Palikea Ridge*</td><td>--</td><td>60-75</td><td>64-79</td><td>12/0</td><td>87/47</td><td>87/28</td></tr>
<tr><td>Palawai</td><td>--</td><td>10</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Other Locations</td><td></td><td></td><td></td><td></td><td></td><td>115</td></tr>
<tr><td>Total Individuals</td><td>--</td><td>220-235</td><td>131-146</td><td>102
(90/12)[†]</td><td>242
(166/76)</td><td>418
(322/96)</td></tr>
</table>

Shaded population units are inside the action area.
*Stabilization population units
[‡]Total mature/immature individuals
[†]Total (mature/immature)

(1) Listing rule (61 FR 53089)
(2) Recovery Plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

<u>Ecology</u> *Hedyotis parvula* typically grows on cliff faces or on exposed rocky ridges. The vegetation in these areas is mesic, low-growing, and sparse, and includes native herbs, grasses, sedges, and shrubs. Plants tend to grow on steep cliffs where ungulates and weeds are not a threat. Flowering and fruiting has been recorded throughout the year. The flowers of *H. parvula* are relatively large and prominently displayed above the plant's foliage, suggesting pollination by night-flying moths; dispersal agents for the fruits are unknown. The longevity of *H. parvula* individuals is unknown, but it is probably similar to that of other small shrubs that live less than 10 years (Makua Implementation Team 2003). Other demographic information for *H. parvula* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

<u>Threats to the Species</u> *Hedyotis parvula* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In addition to military-related wildfire in the action area, arson or careless fires have recently approached the Halona population unit outside the action area. Thus, *H. parvula* has a high background risk of species extinction, and intensive management is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Hedyotis parvula* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain numerical criteria for stabilization population unit for short-lived perennials (Makua Implementation Team 2003). The East Makaleha and Halona population units are not fenced or located within management units. The East Makaleha population unit will be established through reintroduction after fence construction in 2008.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Hedyotis parvula*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Ohikilolo population unit is within the fenced area of the Ohikilolo Management Unit. *Hedyotis parvula* can be successfully propagated from seed and cuttings, but augmentations/reintroductions have not yet been attempted. This species is represented in *ex situ* collections that include 31 cuttings in a nursery (Harold L. Lyon Arboretum), 87 mature fruit in storage at a nursery (Army Environmental Division, Oahu), 122 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 55,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 59 seedlings at a nursery (Harold L. Lyon Arboretum) (Service 2005b; U.S. Army Garrison 2005d).

Critical Habitat Description A total of 540 ha (1,335 ac) of critical habitat in four separate units was designated on Oahu for *Hedyotis parvula*. Critical habitat was designated on Federal land (Lualualei Naval Reservation), State land (Mokuleia Forest Reserve and Kaala Natural Area Reserve), and private land (Honouliuli Preserve). Three of the units provide habitat for one population each and one unit provides habitat for four populations of 300 mature, reproducing individuals (68 FR 35950). To meet recovery goals, a population should be represented by at least 50 mature, reproducing individuals of *H. parvula* (68 FR 35950).

The primary constituent elements of critical habitat include cliff faces or their bases, rock outcrops, or ledges in mesic habitat at elevations between 427 and 1,165 m (1,401 and 3,821 ft). In addition, all units contain one or more of the following associated native plant species: *Bidens* sp., *Carex* sp., *Chamaesyce* sp., *Dodonaea viscosa*, *Eragrostis* sp., *Metrosideros polymorpha*, *M. tremuloides*, *Plectranthus parviflorus*, *Psydrax odorata*, or *Rumex* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 44 percent of all known individuals of *Hedyotis parvula* are located in the Ohikilolo population unit (see Table SB 20). It is estimated 188 individuals occur in the very low fire risk zone. Thus, *H. parvula* in the action area is characterized by two population units that exceed minimum numerical criteria for stabilization and comprise 44 percent of all remaining plants in the zone at very low risk from training-related wildfire.

Status of Critical Habitat in the Action Area The action area contains a total of 7 ha (17 ac) or only one percent of the total critical habitat for *Hedyotis parvula*. This critical habitat is a portion of a larger 380 ha (939 ac) critical habitat unit that extends outside the action area boundary and provides habitat for four population units of *H. parvula*. About one percent of critical habitat for this subspecies is located in an area at risk from training-related wildfire. No acreage is in the high fire risk zone and 7 ha (17 ac) are in the very low fire risk zone. It is estimated that more than half of the critical habitat is in forest habitat with greater than 75 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Hedyotis parvula* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. About one percent of designated critical habitat for this subspecies is located in an area at risk from training-related wildfire. However, because about 44 percent of all known individuals occur within the action area, *H. parvula* in the action area has a high background risk of species extinction, and intensive management is needed to ensure its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Hedyotis parvula* because only one stabilization population unit that meets minimum numerical criteria exists outside the action area, and no population unit is fully stabilized with respect to threat control and genetic storage. Three population units have been identified for stabilization of *H. parvula*: Ohikilolo in the action area, and East Makaleha and Halona outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Other general conservation needs of the subspecies and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

A post-fire revegetation plan should be developed for the West Makaleha Management Unit to be implemented immediately once *Hedyotis parvula* has been reintroduced. Fencing and non-native plant control is needed around habitat for this species within the installation boundary. Research regarding the control of slugs, the black twig borer, and the Chinese rose beetle would benefit many of the plant species identified as primary constituent elements as these pests degrade the overall health and vigor of native habitat. The approval of aerial dispersal of rodenticide within forest habitat would also benefit many native plant species by reducing rat consumption of seeds and plant parts (K. Kawelo, U.S. Army, pers. comm. 2004).

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Ohikilolo population unit, which contains 44 percent of the total remaining individuals of *Hedyotis parvula*, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals, and about one percent of critical habitat designated for this subspecies, are located within the fenced Ohikilolo Management Unit. Goats have been removed, and pigs and weeds are not a threat to this species in the action area. Genetic storage goals are about 66 percent complete working towards meeting the goals outlined in the Makua Implementation Plan. In addition, there is one plant growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Hesperomannia arbuscula* (No Common Name)

Species Description *Hesperomannia arbuscula* is a long-lived perennial shrub in the Asteraceae family. It is a shrub or small tree 2 to 3.3 m (6.6 to 10.8 ft) tall, and may reach up to 7.6 m (25 ft) tall. The leaves are 10 to 18 cm (4 to 7 in) long, 5.5 to 11.5-cm (2.1 to 4.5 in) wide, and covered with tiny hairs. Clusters of four or five yellow, thistle-like flower heads are borne at the stem tips. The perfect florets (with both male and female reproductive parts) project beyond the bracts of the flower head. The achenes (a type of dry, seed-like fruit) are 0.8 to 1 cm (0.3 to 0.4 in) long and tipped with hair-like bristles (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Hesperomannia arbuscula* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species was included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat was designated for *H. arbuscula* on Oahu on June 17, 2003 (68 FR 35950), and on Maui on May 14, 2003 (68 FR 25934). The taxonomic identity of the currently known plants on Maui is in question (Makua Implementation Team 2003).

Historic and Current Distribution *Hesperomannia arbuscula* is endemic to the Waianae Mountains of Oahu and to West Maui. When the species was listed in 1991, only two occurrences of *H. arbuscula* were known on Oahu and only one occurrence on Maui (56 FR 55770). On Oahu, *H. arbuscula* once occurred throughout the Waianae Mountains. The number of individuals in all population units has decreased since 2003, except for the Makaha population unit, where the number of mature individuals has decreased but the number immature individuals has increased. Currently, on Oahu there are 23 known total individuals in four population units located on State and private lands (Table SB 21) (U.S. Army Garrison 2005b). In 2003, there were four occurrences totaling 63 individuals on West Maui but today these population estimates are questionable (Makua Implementation Team 2003). There are no stabilization population units meeting minimum numerical criteria of this species (defined as 75 mature, reproducing individuals per population unit). Trends in reproduction indicate there are very few mature plants, which produce low numbers of seed of very low viability, and hence there is little recruitment in the wild. Thus, *H. arbuscula* on Oahu is characterized by a very low total number of individuals, and little natural regeneration and recruitment.

Table SB 21. Range-wide Distribution of *Hesperomannia arbuscula.*

Population Units	Number of Known Individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kapuna*	--	--	7	1/0‡	1/0	1/0

Kaaikukai	--	--	1	0/0	0/0	0/0
Makaha*	--	--	14	8/0	6/12	5/9
North Palawai*	--	--	7	7/0	4/2	3/1
Waianae Kai	--	--	10	5/1	4/1	2/1
Total Population Units on Oahu	2	4	5	4	4	4
Total Individuals on Oahu	--	--	**39**	**21** (20/1)†	**30** (15/15)	**23** (11/12)
Total Population Units State-wide	3	5	9	8	8	--
Total Individuals State-wide	**50**	**90**	**102**	**90**	**93**	--

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (61 FR 53089)
(2) Recovery Plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Hesperomannia arbuscula* in the Waianae Mountains typically grows in mesic forest on upper gulch slopes and ridge tops at elevations of 597 to 914 m (1,960 to 3,000 ft). The dominant trees at these sites are usually *Metrosideros polymorpha*, *Diospyros sandwicensis*, and *Acacia koa*. Flowering and fruiting usually occurs in the spring in response to rainfall (Service 1998a). The flowers are presumably pollinated by birds, and the bristle-tipped achenes are characteristic of wind-dispersed members of the Asteraceae. However, the achenes of *H. arbuscula* are relatively large and heavy, and plants tend to grow in close colonies, suggesting that seeds are not widely dispersed (Makua Implementation Team 2003). Although the longevity of *H. arbuscula* individuals is unknown, the growth rate and size of the largest plants indicate they may live 10 to 20 years or more (Makua Implementation Team 2003). Other demographic information for *H. arbuscula* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats to the Species *Hesperomannia arbuscula* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section and tabulated in Appendix E. Plants of this species are located along a hunting and hiking trail in the Waianae Kai population unit, where they are particularly vulnerable to damage by feral pigs and hikers. Hikers pick the flowers and have trampled some plants, and pigs have degraded local habitat and killed at least one plant. Even the physical impacts associated with weeding may be harmful to this species (U.S. Army Garrison 2005b).

Occurrences of *Hesperomannia arbuscula* are also vulnerable to extirpation from naturally occurring events such as windstorms and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1998a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *H. arbuscula* in the wild already is in a phase of "quasi-extinction," with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *H. arbuscula* has a very high background risk of species extinction, and any additional threats would eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Hesperomannia arbuscula* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). At least 25 mature, reproducing individuals are needed per population unit to attain numeric criteria for a stabilization population unit for long-lived perennials. Species like *H. arbuscula* with low seed set and recent severe population declines, however, may require 75 mature, reproducing individuals per population unit (Makua Implementation Team 2003). The Kapuna, Makaha, and Waianae Kai population units are not fenced. Part of the Upper Kapuna Management Unit is scheduled for fence construction in 2007 and the Makaha Management Unit in 2008-2009; meanwhile, small population unit fences are planned for construction in 2007 thru 2009 to protect this species from pigs and hikers in the Makaha and Waianae Kai population units. *Hesperomannia arbuscula* so far cannot be successfully propagated for outplanting in the wild. Vegetative propagation from air layering is possible, but success has been poor. Seed storage has not been attempted because so little is produced, and pollen and seed viability are very low. Research is needed on micropropagation techniques and on increasing seed viability through cross-pollination (U.S. Army Garrison 2005b).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Hesperomannia arbuscula*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Only the North Palawai population unit is fenced, and the Kapuna and North Palawai population units are weeded. This species is represented in *ex situ* collections that include one air layer in a nursery (Army Environmental Division, Oahu), eight cuttings in a nursery (Army Environmental Division, Oahu), 78 embryos in micropropagation (Harold L. Lyon Arboretum), 143 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 200 seeds in seed storage (Lyon Arboretum Seed Storage Facility), 35 seedlings in a nursery (Harold L. Lyon Arboretum), and three transplanted wild seedlings in a nursery (Army Environmental Division, Oahu) (Service 2005b).

Critical Habitat Description A total of 1,711 ha (4,228 ac) of critical habitat in seven separate units was designated for *Hesperomannia arbuscula* on Oahu and Maui. Critical habitat was designated on State lands (Mokuleia Forest Reserve, and Pahole and Kaala Natural Area Reserves on Oahu; and West Maui Natural Area Reserve on Maui) and private lands. On Oahu, two of the units provide habitat for one population each, one unit provides habitat for two populations, and two critical habitat units combined provide habitat for one population of *H.*

arbuscula. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *H. arbuscula* (68 FR 35950).

The primary constituent elements of critical habitat on Oahu include slopes or ridges in dry to wet forest dominated by *Acacia koa* or *Metrosideros polymorpha* at elevations between 370 and 1,053 m (1,214 and 3,454 ft). In addition, all Oahu units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma* sp., *Bidens* sp., *Bobea elatior*, *Cyanea longiflora*, *Diospyros hillebrandii*, *Freycinetia arborea*, *Hedyotis terminalis*, *Hibiscus* sp., *Psychotria* sp., or *Syzygium sandwicensis*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Only one mature plant of *Hesperomannia arbuscula*, representing about four percent of all known individuals on Oahu, is located within the action area on State land in the Kapuna population unit (see table above). Seven plants were counted in this population unit in 2003. The single remaining plant reportedly is in poor condition. Vegetative propagation of this plant by air layering has been attempted but has not been successful (U.S. Army Garrison 2005b). The plant is located in an area at very low risk from training-related wildfire.

Status of Critical Habitat in the Action Area The action area contains a total of 213 ha (527 ac) or 12 percent of the total critical habitat for *Hesperomannia arbuscula*. This critical habitat is a portion of a larger 596 ha (1,472 ac) critical habitat unit that extends outside the action area boundary and provides habitat for three populations of *H. arbuscula*. About 12 percent of critical habitat for this subspecies is located in an area at risk from training-related wildfire, but only 0.2 ha (0.6 ac) is located in the high fire risk zone. Approximately 18 ha (44 ac) designated critical habitat are in the low fire risk zone and 195 ha (482 ac) are in the very low fire risk zone. It is estimated that more than half of the critical habitat is in forest habitat with greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Hesperomannia arbuscula* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. About 12 percent of critical habitat for this subspecies is located in an area at risk from training-related wildfire. Any additional threats would eliminate the expectation of its long-term persistence. *Hesperomannia arbusculahas* a very high background risk of extinction due the extremely low number of known individuals.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Hesperomannia arbuscula* because no stabilization population units meet minimum numerical criteria outside the action area. Three population units have been identified for stabilization of *H. arbuscula*: Kapuna in the action area, and Makaha and North Palawai outside the action area. The Kapuna population unit is not fenced, but is located in an area of the Upper Kapuna Management Unit that is scheduled for fencing in 2007. This species need extensive research in order to understand why the species is declining and to reverse this alarming trend. Other general conservation needs of the subspecies and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area</u> The one remaining plant in the Kapuna population unit is being managed as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This plant and about 12 percent of critical habitat designated for this species are located in the action area within the unfenced Upper Kapuna Management Unit. Genetic storage goals are about three percent complete, with six plants meeting the goals outlined in the Makua Implementation Plan. In addition, there are eight plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Hibiscus brackenridgei* ssp. *mokuleianus* (Mao hau hele)

<u>Species Description</u> *Hibiscus brackenridgei* ssp. *mokuleianus* is a short-lived perennial shrub of the Malvaceae (mallow family). It is a sprawling to erect shrub or small tree with lobed, heart-shaped leaves 5 to 15 cm (2 to 6 in) long. The yellow flowers, borne singly or in small clusters, have petals 3.5 to 8 cm (1.4 to 3.2 in) long. The fruits are round or oval capsules 1.1 to 2 cm (0.4 to 0.8 in) long (Wagner et al 1999).

The stature, branching pattern, and morphology of leaves, stems, and flowers of *H. brackenridgei* ssp. *mokuleianus* differ in the three areas on Oahu where the species is currently known. Morphological differences among these "types" are attributable to underlying genetic differences (Makua Implementation Team 2003). The Waialua type (including plants at Kihakapu, Palikea, and Kaimuhole and Kaumoku Nui population units) represents typical *H. brackenridgei* ssp. *mokuleianus* plants, which are single-trunked trees 4 to 7 m (13 to 23 ft) tall with stems densely covered with spines. The Kealia type south of Dillingham Airfield (including the Haili to Kawaiu population unit) is shorter (2 to 6 m (6.5 to 20ft) tall), branches near the ground to form a multi-trunked tree, and has moderately spiny to spineless stems. The recently discovered Makua type morphologically resembles *H. brackenridgei* ssp. *molokaiana*, which previously had been recorded only from West Molokai. The Makua type is a rambling shrub with branches that spread outward, not upwards as in the other two types, and has smaller leaves and no spines. For the purposes of the Makua Implementation Plan and this Biological Opinion, the target taxon consists of the various Oahu and Molokai occurrences of typical *H. brackenridgei* ssp. *mokuleianus* and typical *H. brackenridgei* ssp. *molokaiana*, and occurrences falling between these two morphological extremes (Makua Implementation Team 2003).

<u>Listing Status</u> *Hibiscus brackenridgei*, including two subspecies *H. brackenridgei* ssp. *brackenridgei* and *H. brackenridgei* ssp. *mokuleianus*, was federally listed as endangered on November 10, 1994 (59 FR 56333), and was State listed as endangered at the same time. This

species is included in a recovery plan for multi-island plants (Service 1999a). Critical habitat for this species was designated for Oahu on June 17, 2003 (68 FR 35950); for Hawaii on July 2, 2003 (68 FR 39624); for Maui on May 14, 2003 (68 FR 25934); and for Molokai on March 18, 2003 (68 FR 12982). Three subspecies of *Hibiscus brackenridgei* are now recognized: *brackenridgei*, *mokuleianus*, and *molokaiana* (68 FR 35950). The taxonomic change that recognizes three subspecies is cited in the "Supplement to the *Manual of the Flowering Plants of Hawaii*" (Wagner and Herbst 1999).

Historic and Current Distribution *Hibiscus brackenridgei* is a species endemic to the Hawaiian Islands. Historic data indicate it was known from all the main Hawaiian Islands (Wagner et al 1999). The subspecies *H. brackenridgei* ssp. *mokuleianus* historically was known from scattered locations in the Waianae Mountains of Oahu and West Molokai (Makua Implementation Team 2003). The recent discovery of plants at Makua represents the first record of this subspecies on the leeward side of the Waianae range. When the species was listed in 1994, there were five occurrences totaling about eight individuals of *H. brackenridgei* ssp. *mokuleianus* on Oahu. Currently, this subspecies occurs in five naturally occurring population units (excluding *inter situ*, *ex situ*, and experimentally reintroduced sites) totaling approximately 669 individuals (Table SB 22) (U.S. Army Garrison 2006c). These population units are found on Federal, State, and private lands (68 FR 35950). In addition, several outplantings from Makua stock are located at *inter situ* and *ex situ* sites throughout Oahu.

Since listing, demographic data indicate major improvement in the status of *Hibiscus brackenridgei* ssp. *mokuleianus*. Total numbers within *in situ* population units have increased from 62 in 2003 to 669 in 2006, and about seven percent of the current known individuals are mature plants. Germination and survival of seedlings have increased primarily due to management actions to reduce ungulate damage and weed competition. Nonetheless, there are no population units for this taxon meeting minimum numeric criteria for stabilization (defined as 50 mature, reproducing individuals per population unit for short-lived perennials). *Inter situ* sites have been outplanted on Oahu at Kaiser High School, Kaala Learning Center, and Waimea Botanical Garden; *ex situ* sites have been outplanted at Koko Crater Botanical Garden and Leeward Community College; and experimental reintroductions have been outplanted at Kaluakauila Management Unit on Makua. All plants within the Makua action area, including experimental reintroductions and those in the Makua population unit, are located in high risk fire zones for training-related wildfire. Thus, *H. brackenridgei* ssp. *mokuleianus* is characterized by five population units not reaching minimum stabilization criterion, at low numbers that are at risk of fire, ungulates, and competition from invasive weeds.

Table SB 22. Range-wide Distribution of *Hibiscus brackenridgei* ssp. *mokuleianus*

Population Units	Number of Known Individuals					
	1994 (1)	**1999** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Makua*	--	--	4/3‡	18/8	18/19	16/4
Haili to Kawaiu*	--	--	3/1	1/22	3/10	5/6
Kaimuhole and Palikea Gulch*	--	--	3/5	7/230	7/238	7/238
Kaumoku Nui	--	--	0/2	2/750	2/750	14/0
Kihakapu	--	--	1/2	6/316	6/373	6/373
Total Individuals	**6-8**	**153-203**	**62** (49/13)†	**1398** (72/1326)	**1472** (82/1390)	**669** (48/621)

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (59 FR 56333)
(2) Recovery plan (Service 1999a)
(3) Makua Implementation Plan (Makua Implementation Team 2003), 2004 status report (U.S. Army Garrison 2004a)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Hibiscus brackenridgei* ssp. *mokuleianus* on Oahu occurs on slopes, cliffs, and arid ledges in lowland dry forest and shrubland at elevations of 24 to 490 m (79 to 1,607 ft) (68 FR 35950). The Waialua type occurs in dry gulches, gulch bottoms, and lower to middle gulch slopes in mixed and native dry forest, and the Kealia type occurs on open ledges and bluffs in mixed native and alien grasses, shrubs, and trees (Makua Implementation Team 2003). The Makua type occurs in sites similar to the West Molokai site, on rocky slopes in areas that are drier and more open than any of the other Oahu sites, and in vegetation consisting of mixed native and alien shrubs and grasses. Wild plants of all types lose their leaves at the beginning of the summer dry season, usually by June, and remain dormant until new growth appears with the wet season, usually by October. The three Oahu types vary in growth rates and age at which cultivated plants begin to flower. Most of the cultivated Makua stock flowers at younger than 6 months; cultivated stock of the other types begin to flower at ages ranging from 6 months to 4 years. Flowering occurs from December through June. Flowers open in the afternoon and early evening and remain open until early the next morning, and are pollinated by sphinx or hawk months. Mature seed capsules are present from February through June, and seeds of cultivated plants may remain viable in garden soil for up to 15 years. In the wild, seedlings are often found at locations where no mature plants have been seen for many years. The longevity of *H. brackenridgei* ssp. *mokuleianus* plants in the wild is undocumented, but it is considered a short-lived species because wild populations appear to undergo large fluctuations in numbers (Makua Implementation Team 2003). Other demographic information for *H. brackenridgei* ssp. *mokuleianus* in the wild is unknown, including longevity, number of seeds produced, survivorship to sexual maturity, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements.

Threats to the Species *Hibiscus brackenridgei* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. The Makua type of *H. brackenridgei* ssp. *mokuleianus* is particularly threatened by fire, weeds, and predation by the Chinese rose beetle and other insects (Makua Implementation Team 2003; U.S. Army Garrison 2005b). In addition, *H. brackenridgei* ssp. *mokuleianus* in areas near human habitation is threatened by hybridization and genetic contamination from the related, cultivated taxon *H. brackenridgei* ssp. *brackenridgei*, which is sold in commercial nurseries and does not occur naturally on Oahu or Molokai (Makua Implementation Team 2003). This taxon experiences large population fluctuations related to drought and its natural recruitment is severely reduced by feral ungulates and invasive weeds. Occurrences also are vulnerable to extirpation from naturally occurring events such as windstorms and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 56333; 68 FR 35950; Service 1999a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *H. brackenridgei* ssp. *mokuleianus* in the wild already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *H. brackenridgei* ssp. *mokuleianus* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Hibiscus brackenridgei* ssp. *mokuleianus* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). At least 50 mature, reproducing individuals typically are needed in each of at least three population units to attain stabilization for short-lived perennials. However, species subject to common, large fluctuations in numbers may require a stabilization target of at least 100 mature individuals for each population unit. Due to the persistence of *H. brackenridgei* ssp. *mokuleianus* seeds in the soil seed bank, increasing the numerical criterion for stabilization is not warranted for this species. However, locations of historical occurrences should be surveyed for new regeneration from seed (Makua Implementation Team 2003). The Haiwi to Kawaiu population unit, and Kaimuhole and Palikea Gulch population unit, are stabilization population units located on private lands in remote, steep, invasive weed-dominated areas. The Army does not plan to manage these sites because they are not considered viable in the long-term. Instead of managing wild individuals in these population units, the Army proposes to establish reintroductions with stock from these population units in more manageable areas on Dillingham Military Reservation. In addition, the Army recently determined that the private landowner of land designated as the Kaimuhole Management Unit is unwilling to give permission for fence construction (U.S. Army Garrison 2006c). Therefore, the Army is seeking a replacement management unit and stabilization population unit for the Kaimuhole and Palikea Gulch population unit.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Hibiscus brackenridgei* ssp. *mokuleianus*, which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). One population unit for each of the three morphological types is being managed for stabilization (U.S. Army Garrison 2005b). In addition, this subspecies occurs in two management units where it will benefit from population unit and/or ecosystem-level protection. The management units are Haili to Kealia (subunits I and II), which is not fenced, and Lower Ohikilolo, which is fenced. Stock from three of the five wild population units has been established in *inter situ* and *ex situ* sites around Oahu. *Hibiscus brackenridgei* ssp. *mokuleianus* grows easily from cuttings, produces many flowers and seeds in a season, and there is good recruitment at *inter situ* sites. Much of the seed collected, however, is unviable (U.S. Army Garrison 2005b).

In 2005, additional current State-wide *ex situ* collections for the species *Hibiscus brackenridgei* included 10 vegetative buds in micropropagation (Harold L. Lyon Arboretum), 23 cuttings in nurseries (Army Environmental Division, Oahu, and Harold L. Lyon Arboretum), 83 plants in nurseries (Harold L. Lyon Arboretum and Volcano Rare Plant Facility), 229 plants in botanical gardens (Amy Greenwell Ethnobotanical Garden, Maui Nui Botanical Garden, and Waimea Valley Audubon Center), two ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 17,895 seeds in seed storage (Lyon Arboretum Seed Storage Facility and Maui Nui Botanical Garden), and three seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

<u>Critical Habitat Description</u> A total of 1,814 ha (4,482 ac) of critical habitat, in seven separate units, was designated for *Hibiscus brackenridgei* on four islands. However, only Oahu critical habitat units provide habitat for the taxon *H. brackenridgei* ssp. *mokuleianus*. On Oahu, 661 ha (1,634 ac) of critical habitat was designated in three units on State (including Mokuleia Forest Reserve) and private lands. The three Oahu units provide habitat for three populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *H. brackenridgei* (68 FR 35950).

The primary constituent elements for two of the critical habitat units on Oahu include slopes, cliffs, or arid ledges in lowland dry forest or shrubland at elevations of 32 to 490 m (105 to 1,607 ft). In addition, these units contain one or more of the following associated native plant species: *Bidens amplectens*, *Chamaesyce* sp., *Diospyros hillebrandii*, *Dodonaea viscosa*, *Doryopteris* sp., *Erythrina sandwicensis*, *Heteropogon contortus*, *Lepidium bidentatum*, *Melanthera remyi*, *Pleomele halapepe*, *Psydrax odorata*, *Reynoldsia sandwicensis*, *Sida fallax*, or *Waltheria indica*. The primary constituent elements for the other unit on Oahu, for the Makua type, include dry shrublands at elevations of 32 to 490 m (105 to 1,607 ft) and containing one or more of the following associated native plant species: *Doryopteris* sp., *Dodonaea viscosa*, *Heteropogon contortus*, *Sida fallax*, or *Waltheria indica*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

<u>Threats to the Critical Habitat</u> See introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 3 percent of all known *in situ* individuals of *Hibiscus brackenridgei* ssp. *mokuleianus* (excluding *inter situ*, *ex situ*, and experimental outplantings) are located within the action area, in the Makua population unit located on Makua (see Table SB 22). The 16 naturally occurring, mature individuals in the action area represent about 33 percent of all in situ and reintroduced individuals. The Makua population unit has been monitored only since 2003, and has increased from 7 to 20 total individuals since then. At about 16 mature individuals, the Makua population unit is not meeting minimum numerical criteria for stabilization (defined as 50 mature, reproducing individuals). This population unit has burned many times, but recent germination suggests the soil seed bank is still viable if the alien grass *Panicum maximum* is removed and controlled (U.S. Army Garrison 2005b). The Makua population unit is located within the Lower Ohikilolo Management Unit at the seaward end of Ohikilolo ridge, in sparse, lowland dry cliff vegetation adjacent to non-native grassland. Since 2002, the Army has experimentally reintroduced about 46 individuals into the Kaluakauila population unit; these plants are not counted as naturally occurring (*in situ*) individuals. The 2003 prescribed burn damaged three of these plants and killed one (U.S. Army Garrison 2004a). Therefore, the Army will not maintain the Kaluakauila sites because of the constant high risk of fire threat in that location (U.S. Army Garrison 2005b). The Makua population unit of 20 total individuals is located in a high risk fire zone from military training. *Ex situ* individuals on Makua previously included 34 mature outplants at the Range Control office. These plants were removed in 2004 because of possible hybridization and pollen competition concerns (U.S. Army Garrison 2004a).

Hibiscus brackenridgei ssp. *mokuleianus* is resilient, persists in poor habitat, does well in cultivation, and shows significant recruitment at *inter situ* sites (U.S. Army Garrison 2005b). Although *H. brackenridgei* ssp. *mokuleianus* in the action area represents only 3 percent of the taxon's range-wide total *in situ* population, it represents 33 percent of all *in situ* individuals. Thus, *H. brackenridgei* ssp. *mokuleianus* in the action area is characterized by one population unit that does not meet minimum criterion for stabilization, low numbers of individuals and is located within the high fire risk zone.

Status of the Critical Habitat in the Action Area The action area contains a negligible fragment (0.04 ha or 0.1 ac) of the total critical habitat designated for *Hibiscus brackenridgei* ssp. *mokuleianus*. Although this fragment is located in a high fire risk zone on State and private lands in the southwest part of the action area, it is considered to have minimal existing conservation value for the species because of non-native threats.

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Hibiscus brackenridgei* ssp. *mokuleianus* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Hibiscus brackenridgei* ssp. *mokuleianus* in the action area is particularly vulnerable to wildfire from military training activities and competition from non-native grasses and invasive weeds. *Panicum maximum* requires significant control effort and is a major fire risk (U.S. Army Garrison 2005b). State-wide, the action area critical habitat represents a negligible proportion of total critical habitat for this species. Thus, because about 33 percent of all known mature, *in situ* individuals occur within the action area, *H. brackenridgei* ssp. *mokuleianus* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Hibiscus brackenridgei* ssp. *mokuleianus* because population units do not meet minimum numeric stabilization criterion either inside or outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Stabilization goals to improve the status of *H. brackenridgei* ssp. *mokuleianus* include management to attain three population units, each with a minimum of 50 mature, reproducing individuals. Three population units have been identified for stabilization of *H. brackenridgei* ssp. *mokuleianus*: Makua within the action area, and Haili to Kawaiu and Kaimuhole and Palikea Gulch outside the action area. The Haili to Kawaiu and Kaimuhole and Palikea Gulch population units are on private lands, where any future fence construction will depend on landowner cooperation; as noted above, the owner of the Kaimuhole and Palikea Gulch population has already declined to participate. Because *H. brackenridgei* ssp. *mokuleianus* occurs in a high fire risk zone within the action area, the Army also proposes to reintroduce the Makua type in the Keaau part of the action area, in a low fire risk zone which will be fenced and weeded as a fourth population unit to manage for stabilization (M. Mansker, pers. comm, 2006). In addition, a post-fire revegetation plan and site-specific fuel modification are needed where this species occurs in the action area, and fuelbreak gaps along the firebreak roads should be maintained consistently (U.S. Army Garrison 2005b). The non-native insect *Niesthrea louisianica* (Rhopalidae) was recently observed on *H. brackenridgei* ssp. *mokuleianus* outplanted at Range Control. This insect was introduced for study as a biocontrol agent for the non-native weed *Abutilon theophrasti* and reduces its seed viability by 98 percent. Research is needed to determine if this insect is a source of seed predation on *H. brackenridgei* ssp. *mokuleianus* in the action area, and if so, to develop control techniques (U.S. Army Garrison 2005b). Past fires at Makua, including the August 2005 white phosphorus fire, have jumped the firebreak road in the vicinity of the Makua population unit. In the opinion of Army Natural Resources Staff, fire-fighting and helicopter support are “vital” to protect this population unit from burning (U.S. Army Garrison 2005b). Other general conservation needs of the species in the action area are the same as those described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Makua population unit in the action area contains 33 percent of the total remaining mature, *in situ* individuals of *Hibiscus brackenridgei* ssp. *mokuleianus*. This population unit is being managed for stabilization as specified in the` Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). The Makua population unit in the Lower Ohikilolo Management Unit is protected by a fence, goats have been virtually eradicated from Makua, and weeds are controlled around plant sites. A 30 m (98 ft) chemically controlled fuelbreak is maintained inside the firebreak road, a 10 m (33 ft) fuelbreak is maintained outside the firebreak road, and a 30-m (98 ft) wide, 1.4 ha (3.5 ac) fuelbreak is maintained directly around the *H. brackenridgei* ssp. *mokuleianus* population unit (U.S. Army Garrison 2005b). A total of about 42.6 ha (105.1 ac) of critical habitat for this species is located within management units both within and outside of the action area (Haili to Kealia, Kaimuhole), of which only a negligible amount is located inside the action area. As of 2005, genetic storage goals for this species were about 13 percent complete, with 33 plants from all five *in situ* population units combined meeting the goals of the Makua Implementation Plan, and there were 43 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Critical Habitat – *Isodendrion laurifolium* (Aupaka)

Critical Habitat Description A total of 1,757 ha (4,342 ac) of critical habitat was designated for *Isodendrion laurifolium* in five separate units on Kauai and Oahu. Approximately 800 ha (1,979 ac) were designated on Kauai and 955 ha (2,362 ac) were designated on Oahu. Critical habitat has been designated on State (Kuia Natural Area Reserve and Alakai Wilderness Preserve on Kauai; Mokuleia, Waianae Kai, and Honolulu Watershed Forest Reserves, and Pahole and Kaala Natural Area Reserves on Oahu) and private lands. On Kauai, two units provide habitat for two populations each, and on Oahu, one unit provides habitat for four populations and two units provide habitat for one population of *I. laurifolium*. The recovery goal is that each population will be represented by a minimum of 300 mature, reproducing individuals (68 FR 9116, 68 FR 35950).

The primary constituent elements of the units on Oahu include gulch slopes, ravines, or ridges in diverse mesic or dry forest dominated by *Metrosideros polymorpha*, *Acacia koa*, *Eugenia reinwardtiana*, or *Diospyros sandwicensis* and containing one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma platyphyllum*, *A. pulvinatum*, *Carex wahuensis*, *Charpentiera tomentosa*, *Doodia* sp., *Dryopteris unidentata*, *Hedyotis terminalis*, *Hibiscus arnottianus*, *Nestegis sandwicensis*, *Pisonia* sp., *Pouteria sandwicensis*, *Psydrax odorata*, *Rauvolfia sandwicensis*, *Sapindus oahuensis*, *Smilax melastomifolia*, or *Xylosma hawaiiense*, at elevations between 180 and 959 m (590 and 3,146 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat for this species on Oahu include habitat degradation by feral goats and pigs, competition with non-native plant species, and potential threats from military activities (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Four percent or 62 ha (153 ac) of the designated critical habitat for *Isodendrion laurifolium* is found in one unit within the Makua action area. The critical habitat unit is located in the northeastern portion of the action area and is in the area of low fire risk. This portion of the critical habitat in the action area, together with 554 ha (1,371 ac) outside the Makua action area, provides habitat for the conservation of four populations of *I. laurifolium*. It is estimated that more than one-half of the critical habitat is located in an area with 50 to 75 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Critical Habitat in the Action Area Threats to the critical habitat include military training; habitat degradation and/or destruction by feral goats and pigs; competition from non-native plant species such as *Aleurites moluccana*, *Cordyline fruticosa*, *Grevillea robusta*, *Psidium cattleianum*, *Schinus terebinthifolius*, and *Toona ciliata*. In addition, rats, slugs, the black twig borer and the Chinese rose beetle impact native habitat (68 FR 35950).

<u>Ongoing Conservation Actions for the Critical Habitat Within the Action Area</u> Seventy one percent, 44 ha (108 ac), of the critical habitat within the action area coincides with management units (Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha). Fence exclosures are planned for the West Makaleha and Upper Kapuna Management Units. Non-native plants and ungulates are controlled within the West Makaleha and Upper Kapuna Management Units (K. Kawelo, pers. comm. 2004).

Status of the Critical Habitat – *Isodendrion longifolium* (Aupaka)

<u>Critical Habitat Description</u> A total of 2,127 ha (5,255 ac) of critical habitat has been designated for *Isodendrion longifolium* in seven separate units on Kauai and Oahu. Approximately 1,414 ha (3,488 ac) were designated in five units on Kauai and 714 ha (1,762 ac) in two units on Oahu. Critical habitat has been designated on State (Halelea Forest Reserve, Hono o Na Pali Natural Area Reserve, and, Kokee and Na Pali Coast State Parks) and private lands on Kauai and on private and State (Mokuleia Forest Reserve and Mt. Kaala Natural Area Reserve) lands on Oahu. On Kauai, one unit provides habitat for two populations and four units provide habitat for one population each, and, on Oahu, one unit provides habitat for three populations and one unit provides habitat for one population of *I. longifolium*. Each population is to be comprised of a minimum of 300 mature, reproducing individuals (68 FR 9116; 68 FR 35950).

The primary constituent elements of the units on Oahu include steep slopes or stream banks in mixed mesic or lowland wet *Metrosideros polymorpha-Dicranopteris linearis* forest containing one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma* sp., *Bobea brevipes*, *Carex* sp., *Cyanea* sp., *Cyrtandra* sp., *Hedyotis terminalis*, *Isachne pallens*, *Melicope* sp., *Peperomia* sp., *Perrottetia sandwicensis*, *Pittosporum* sp., *Pouteria sandwicensis*, *Psydrax odorata*, *Psychotria* sp., *Selaginella arbuscula*, or *Syzygium sandwicensis*, and elevations between 316 and 880 m (1,036 and 2,886 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

<u>Threats to the Critical Habitat</u> On Oahu, the critical habitat for is threatened by habitat degradation and/or destruction by feral goats and pigs, non-native plants, and a risk of habitat degradation from naturally occurring stochastic events (68 FR 35950)

Environmental Baseline of the Critical Habitat

<u>Status of the Critical Habitat in the Action Area</u> Less than one percent, 0.5 ha (1 ac), of the designated critical habitat for *Isodendrion longifolium* is located in one unit in the northeastern portion of the Makua action area in the low fire risk area. This portion of the critical habitat in

the action area, together with 551 ha (1,362 ac) outside the action area, provides habitat for the conservation of three populations of *I. longifolium.* It is estimated that the majority of the critical habitat is located in an area with less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Critical Habitat in the Action Area The primary threats to the critical habitat include habitat degradation or destruction by feral goats and pigs, a risk of habitat degradation from naturally occurring stochastic events, and fire caused by military training activities. Non-native plants such as *Ageratina riparia*, *Clidemia hirta*, *Oplismenus hirtellus*, *Paspalum conjugatum*, *Psidium cattleianum*, and *Christella parasticia* outcompete the vegetative primary constituent elements to further degrade habitat quality and plant vigor (68 FR 35950).

Ongoing Conservation Actions for Critical Habitat Within the Action Area One hundred percent, 0.5 ha (1 ac), of the critical habitat is located within the West Makaleha Management Unit. Construction of a fence is planned for the West Makaleha Management Unit (K. Kawelo, pers. comm. 2004).

Status of the Critical Habitat – *Isodendrion pyrifolium* (Aupaka)

Critical Habitat Description A total of 535 ha (1,322 ac) of critical habitat was designated for *Isodendrion pyrifolium* in five separate units on three islands. Critical habitat was designated on State (e.g., West Maui Forest Reserve and West Maui Natural Area Reserve on Maui, and Nanakuli Forest Reserve on Oahu) and private lands. Each unit provides habitat for one or more populations, each with a minimum of 300 mature, reproducing individuals of *I. pyrifolium*. On Maui, 224 ha (555 ac) in one unit was designated to provide habitat for two populations; one unit of 107 ha (246 ac) was designated on Molokai to provide habitat for one population; and 233 ha (573 ac) in three units was designated to provide habitat, for one population each, on Oahu (68 FR 12982; 68 FR 25934; 68 FR 35950).

The primary constituent elements of the units on Oahu include bare rocky hills or wooded ravines in dry shrublands, and elevations from 37 to 692 m (121 to 2,270 ft). The plant community and elevation are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat on Oahu for this species are unknown as this species is no longer extant on this island (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Less than one percent, or 1 ha (3 ac), of the designated critical habitat for *Isodendrion pyrifolium* occurs within the Makua action area. This critical habitat unit provides habitat for the conservation of one population of *I. pyrifolium*. Located in the southwestern portion of the action area, the critical habitat is in both the high fire risk zone and low fire risk zones.

Threats to the Critical Habitat in the Action Area The primary threats to critical habitat in the action area are unknown; however, based on current information regarding general threats to plant critical habitat, feral ungulates, non-native plant species, and fire are all likely to be significant (K. Kawelo, pers. comm. 2004).

Ongoing Conservation Actions Within the Action Area Only two percent, or 0.03 ha (0.08 ac), of the critical habitat in the action area is in the Lower Ohikilolo Management Unit. This management unit is fenced and the Army is working to control non-native plants to reduce the risk of fire (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Lepidium arbuscula* (Anaunau)

Species Description *Lepidium arbuscula* is a short-lived perennial in the Brassicaceae (mustard) family. This species is a gnarled shrub, 0.6 to 1.2 m (2 to 4 ft) tall, with leaves crowded at the ends of the branches. The leaves are 2.6 to 6.0 cm (1.0 to 2.4 in) long and 0.8 to 1.8-cm (0.3 to 0.7 in) wide. The small white flowers form one to three erect simple racemes, 7 to 15 cm (2.8 to 5.9 in) long. The fruit is short and ovate to suborbicular in shape, and 3.5 to 4 mm (0.1 to 0.2 in) long and wide. The reddish brown seeds are 1.5 to 2.0 mm (0.1 in) long. *Lepidium arbuscula* is the only native *Lepidium* in the Waianae Mountains and is distinguished from others in the genus by its height (Wagner et al 1999).

Listing Status *Lepidium arbuscula* was federally listed as endangered on October 10, 1996, and State listed as endangered in Hawaii at the same time. A recovery plan was prepared for this species in 1998 (61 FR 53108; Service 1998a). Critical habitat was designated for this species on Oahu in 2003 (68 FR 35950).

Historic and Current Distribution Historically, *Lepidium arbuscula* was known from scattered localities throughout the Waianae Mountains. Currently, approximately 900 individuals in 10 small, widely dispersed occurrences are distributed from Kuaokala in the northern Waianae Mountains to Lualualei-Nanakuli Ridge in the southern Waianae Mountains. These occurrences include Ohikilolo, Makua-Keaau Ridge, Kapuhi Gulch, and Manini Gulch, Pahoa and Halona, northwest of Puu Kaua, Halona, Lualualei-Nanakuli Ridge, Kamaileunu Ridge, and Mohiakea Gulch (Table SB 23).

Table SB 23. Range-wide Distribution of *Lepidium arbuscula*.

Occurrences	Number of Known Individuals				
	1996 (1)	**1998-1999** (2)	**2003** (3)	**2003** (4)	**2005** (5)
Ohikilolo	--	--	--	1	10/0‡
Keeau	--	--	--	60	30/6
Lower Makua	--	--	--	--	1/0
Manini Gulch	<10	<10	--	1	--
Kuaokala	--	--	--	--	5/0

Mohiakea (SBW)	<10	<10	--	10	10/0
South of Pohakea Pass	--	--	--	--	50+
Pohakea Pass to Kolekole Pass	--	--	--	--	50+
Kamaileunu	--	--	--	--	50+
Total Individuals	**<900**	**<900**	**1000**	**906**	**900**

Shaded occurrences are inside the action area.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (61 FR 53089)
(2) Recovery plan (Service 1998a), Makua Endangered Species Mitigation Plan (U.S. Army Garrison 1999a)
(3) Critical habitat rule (68 FR 35950)
(4) Oahu Biological Opinion (Service 2003a)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology *Lepidium arbuscula* generally grows on exposed ridge tops and cliff faces in mesic and dry vegetation communities between 131 and 978 m (430 and 3,208 ft) in elevation. This species is typically associated with native plant species such as *Artemisia australis*, *Bidens* sp., *Carex meyenii*, *C. wahuensis*, *Chamaesyce multiformis*, *Dodonaea viscosa*, *Dryopteris unidentata*, *Dubautia* sp., *Eragrostis variabilis*, *Leptecophylla tameiameiae*, *Lysimachia hillebrandii*, *Metrosideros polymorpha*, *Peperomia* sp., *Psydrax odorata*, *Rumex albescens*, *Schiedea ligustrina*, *Sida fallax*, or *Sophora chrysophylla*. *Lepidium arbuscula* has been observed in flower in February but little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Threats to the species *Lepidium arbuscula* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section and tabulated in Appendix E. The primary threats to *L. arbuscula* include loss of habitat and degradation of the remaining habitat by non-native plants and animals. Non-native plants compete with *L. arbuscula* for nutrients, light, and space. Feral goats threaten *L. arbuscula* by browsing on plants, trampling individuals, and causing general habitat destruction. The occurrences located on military land are threatened by fire caused by military training actions. The occurrence at the head of Kapuhi Gulch is also threatened by its proximity to a road (68 FR 35950).

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Lepidium arbuscula* are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section. Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). Conservation actions required for stabilization are described in the “Stabilization” section of the project description for this opinion. However, *L.*

arbuscula is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua and Oahu action areas (Service 2003a).

The recovery plan for this species identifies several important conservation actions that should be implemented for the conservation *Lepidium arbuscula*. To reduce impacts from feral goats, exclosures or strategic barrier fences should be constructed around all the known occurrences of *L. arbuscula,* where feasible. Control or removal of goats from these areas and the broader landscape will alleviate their impact on native ecosystems. Non-native plants should be controlled or removed from the vicinity of all known occurrences of *L. arbuscula*. Occurrences that have only a few remaining individuals should be given priority to conserve genetic representation (Service 1998a).

Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Lepidium arbuscula*. This plan will also include broader landscape actions that are needed for the recovery of this species throughout its range (Hawaii and Pacific Plant Recovery Coordinating Committee 2007). The National Tropical Botanical Garden has seeds of this species in storage. The Service is currently not aware of any other conservation efforts for this species (Service 2003a).

Environmental Baseline of the Species

Status of the Species in the Action Area Currently, approximately 10 percent, or approximately 125 individuals, of the known *Lepidium arbuscula* plants are found in the Makua action area. None of the occurrences in the action area have reached the minimum number (50) of mature, reproducing individuals threshold, as required for stabilization populations. However, the Holona occurrence, within the action area, is nearing this threshold with 45 mature individuals and 31 immature individuals. Four occurrences in the action area are within a fenced unit. These occurrences harbor approximately 110 individuals. The other four action area occurrences are not fenced and none of the action area occurrences are actively managed by the Army. *Lepidium arbuscula* plants in the action area are located in areas at risk from training-related wildfire; however all individuals occur in the low fire risk zone. Thus, *L. arbuscula* in the action area is characterized by seven population units, with the total number of individuals per population unit ranging from 3 to 76 (all with fewer than 50 mature, reproducing individuals) and all of which are located within low fire risk zones.

Threats to the Species The primary threats to *Lepidium arbuscula* and its critical habitat in the action area are those described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section and tabulated in Appendix E. The major threats to *L. arbuscula* are fire from military training activities, competition with non-native plants, and habitat degradation and/or destruction by feral goats (Service 1999b).

Conservation Needs of the Species Pursuant to the guidelines established in the Makua Implementation Plan, *Lepidium arbuscula* will not be stabilized because there are at least three stabilization population units known to exceed minimum numeric criteria outside of the Makua action area. However, the Oahu Implementation Team will review the status of this species to determine if any species-specific conservation actions are needed, such as collection for genetic storage. *Lepidium arbuscula* would benefit from additional conservation actions such as fencing, ungulate removal, reduction of non-native plant species, and control of wildfires (Service 2003a and 1999b). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section.

<u>Ongoing Conservation Actions for the Species</u> The Army has constructed a fence that protects the Makua-Keaau Ridge plants from further feral goat damage. The Service is currently not aware of any other conservation efforts for this species in the action area (Service 2003a).

Status of the Species and Critical Habitat – *Lobelia niihauensis* (No Common Name)

<u>Species Description</u> *Lobelia niihauensis*, a short-lived perennial member of the Campanulaceae (bellflower) family, is a small, branched shrub. Each branch ends in a rosette of leaves which are 7 to 15 cm (2.6 to 5.94 in) long and 0.7 to 1.8-cm (0.3 to 0.7 in) wide. Magenta flowers are clustered at the ends of branches and produce an egg-shaped capsule 5 to 8 mm (0.2 to 0.3 in) long with many small brownish seeds. This species is distinguished from others in the genus by its leaves lacking or nearly lacking leaf stalks, the magenta-colored flowers, the width of the leaf, and length of the flower (Wagner et al 1999)

<u>Listing Status</u> *Lobelia niihauensis* was federally listed as endangered on October 29, 1991, and State listed as endangered in Hawaii at the same time. A recovery plan was prepared for this species in August 1995 and August 1998 (Service 1995a; Oahu Service 1998a; 56 FR 55770). Critical habitat was designated for *L. niihauensis* on Kauai on February 27, 2003, and on Oahu on June 17, 2003 (56 FR 55770; 68 FR 9115; 68 FR 35950).

<u>Historic and Current Distribution</u> Historically, *Lobelia niihauensis* was known from the Waianae Mountains of Oahu (Uluhulu Gulch to Nanakuli Valley), Kauai, and Niihau. It is now known to be extant only on Kauai and Oahu. On Oahu, this species is found on Ohikilolo Ridge, Kaimokuiki-Manuwai Ridge, Kamaileunu Ridge, Mt. Kaala, Makaha-Waianae Kai, Makua, Nanakuli, South Mohiakea Gulch, east of Puu Kalena, Kahanahaiki Valley, between Puu Hapapa and Puu Kanehoa, Puu Kailio, between Kolekole Pass and Puu Hapapa, North of Palikea, Puu Kaua-Kauhiuhi-Pahoa-Halona subdistricts, and Lualualei Naval Magazine (Table SB 24). It is estimated there are 40 occurrences of *L. niihauensis* with a total population of between 350 and 400 individuals on Federal, State, city, and county lands (68 FR 35950).

Table SB 24. Range-wide Distribution of *Lobelia niihauensis*.

Occurrences	Number of Known Individuals				
	1991 (1)	1995 (2)	1999 (3)	2005 (4)	2006 (5)
Ohikilolo	--	--	~420	400+	150
Kahanahaiki	--	--		8	
Eastern Makua	--	--		12	

Keaau	--	--		59	80/41
Kauhiuhi Gulch	--	--	--	--	4/0
Waianae	--	--	90-120	--	30/0
Lualualei	--	--	110	--	--
Puu Kumakalii	--	--	--	--	1/0
Kolekole	--	--	--	--	3/0
Makaha	--	--	--	--	50/50
Manuwai	--	--	--	--	2/0
Mohiakea	--	--	10	10/0‡	--
Nanakuli FR	--	--	12	--	--
Other Locations on Oahu	--	--	--	223-253	--
Total Population Units on Oahu	--	--	14	6	7
Total Individuals on Oahu	--	--	**625-655**	**702-732**	**411** (170/91 +150)†
Total Population Units on Kauai	--	--	6	3+	--
Total Individuals on Kauai	--	--	**960-2900**	**960-2900**	--
Total Population Units State-wide	40	33	20	9+	--
Total Individuals State-wide	**400-1400**	**>2000**	**1585 - 3555**	**1661-1971**	**--**

Shaded population units are inside the action area.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR 55770)
(2) Recovery Plan (Service 1995a)
(3) Biological Opinion (Service 1999b)
(4) Army re-initiation request (U.S. Army Garrison 2005c)
(5) Army database (U.S. Army Garrison 2006d)

Ecology *Lobelia niihauensis* typically grows on exposed mesic to dry cliffs at elevations of 100 to 830 m (330 to 2,720 ft). Associated plants include *Artemisia australis*, *Bidens* spp., *Eragrostis variabilis*, *Lipochaeta* sp., and *Plectranthus parviflorus*. *Lobelia niihauensis* flowers in late summer and early fall. Fruits mature one month to six weeks later. Plants are known to live as long as 20 years. Few juveniles are observed in the wild (U.S. Army Garrison 1999a).

Threats to the species *Lobelia niihauensis* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section and tabulated in Appendix E. On Oahu, the current major threats to *L. niihauensis* are habitat degradation and predation by feral goats, rats, and slugs; fire; military activities; and competition from non-native plants. On Kauai, the major threats are habitat degradation and predation by goats and competition from non-native plants (U.S. Army Garrison 1999a). *Lobelia niihauensis* has a moderate background risk of extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Lobelia niihauensis* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). However, *L. niihauensis* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in its action areas on Oahu (Service 2003a). The recovery plan for this species identifies important conservation actions including fencing, non-native plant control, protection from fire, and outplanting of local genetic material (Service 1998a).

Ongoing Conservation Actions Propagation material for this species is currently held at the following institutions: Harold L. Lyon Arboretum, National Tropical Botanical Garden, and The Nature Conservancy Hawaii, Oahu. In addition, a State-wide strategic plan is being developed by the Hawaii and Pacific Plant Recovery Coordinating Committee that will address the long-term conservation of *Lobelia niihauensis.* This plan will also include broader landscape actions that are needed for the recovery of this species throughout its range. Currently, no other management actions are known for this species outside of the Makua action area (Hawaii and Pacific Plants Recovery Coordinating Committee 2007; Service 1999b).

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area In the Makua action area, *Lobelia niihauensis* is known from Makua and Kahanahaiki Valleys. Most of these plants are on the cliffs (Ohikiklolo Ridge) on the southern side of Makua Valley, where more than 400 plants were seen during the Hawaii Natural Heritage Program survey in 1993. The Makua population (approximately 500 individuals) represents more than 70 percent of the known individuals on Oahu (U.S. Army Garrison 2005c) and approximately 20 percent of the estimated 1,585 to 3,555 individuals of *L. niihauensis* State-wide (Service 1999a).

Threats to the Species The primary threats to *Lobelia niihaunesis* are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The major threats to *L. niihauensis* within the Makua action area include fire from military activities; competition with non-native plants such as *Ageratina riparia*, *Erigeron karvinskianus*, *Leucaena leucocephala*, *Melinis minutiflora*, and *Schinus terebinthifolius*; and habitat degradation and/or predation by feral goats, rats, and slugs (Service 1999a).

Conservation Needs of the Species *Lobelia niihauensis* does not require stabilization across its range because there are at least three stabilization population units that have exceeded minimum numeric criteria known outside of the Army action area. This species will benefit from habitat level management implemented for other Makua endangered species (Service 1999a). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species The Army has completed a fence that runs the south and southeast perimeter of Makua Valley, protecting the plants on Ohikilolo Ridge. Management activities where this species is located include fencing, weeding, ungulate control, rat baiting, fuel modification, firebreak management, habitat restoration, and slug control (K. Kawelo, pers. comm. 2004).

Status of the Critical Habitat – *Mariscus pennatiformis* (No Common Name)

Critical Habitat Description A total of 1,370 ha (3,385 ac) of critical habitat was designated for *Mariscus pennatiformis* in five separate units on Kauai, Maui, Laysan and Oahu. Each unit provides habitat for one or more populations, each comprised of a minimum of 300 mature, reproducing individuals of *M. pennatiformis*. Critical habitat has been designated on Federal (e.g., Laysan Island in the Hawaiian Islands National Wildlife Refuge), State (e.g., Kuia Natural Area Reserve, Kokee and Waimea Canyon State Parks on Kauai; and Pahole Natural Area Reserve and Mokuleia Forest Reserve on Oahu) and private lands. The two critical habitat units on Oahu each provides habitat for two populations of *M. pennatiformis* (68 FR 9116; 68 FR 25934; 68 FR 28054; 68 FR 35950).

The primary constituent elements of the Oahu units include mesic and wet *Metrosideros polymorpha* forest and *Metrosideros polymorpha-Acacia koa* forest, and elevations between 424 and 1,032 m (1,391 and 3,385 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The major threats to the critical habitat include habitat degradation by feral pigs and fire from military training activities. Non-native plant species compete for light, space and nutrients (K. Kawelo, pers. comm. 2004).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Thirteen percent, 166 ha (410 ac), of the designated critical habitat for *Mariscus pennatiformis* is located in one unit in the northeastern portion of the Makua action area. This area is entirely in an area of low fire risk. This critical habitat unit provides habitat for the conservation of two populations of *M. pennatiformis*. It is estimated that almost all the critical habitat in the action area is located in an area that has greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Critical Habitat in the Action Area The major threats to the primary constituent elements of the critical habitat include habitat degradation by feral pigs, and wildfire from military training activities. Non-native plant species such as *Blechnum appendiculatum*, *Clidemia hirta*, *Grevillea robusta*, *Melinis minutiflora*, *Paspalum conjugatum*, *Psidium cattleianum*, *Rubus argutus*, *Schinus terebinthifolius*, and/or *Stachytarpheta australis* compete for light, space, and nutrients. In addition, critical habitat is threatened by predation of associated native plants by rats, slugs, the black twig borer and the Chinese rose beetle (K. Kawelo, pers. comm. 2004).

Ongoing Conservation Actions for the Critical Habitat Within the Action Area   Ninety-six percent, 139 ha (344 ac), of the critical habitat in the action area is within management units (Kahanahaiki, Pahole, Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha). Fuel modification and rat control are ongoing in the Kahanahaiki Management Unit. The Pahole Management Unit is fenced and construction of additional fence exclosures for the West Makaleha and Upper Kapuna Management Units is planned. The Army currently controls non-native plants and ungulates within the Pahole, West Makaleha, and Kahanahaiki management units (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Melanthera tenuifolia* (Nehe)

Species Description   *Melanthera tenuifolia* is a short-lived perennial herbaceous plant in the Asteraceae (sunflower) family. The main stems can grow several meters long and may rest on the ground or on other plants, and roots sprout along the undersides of the stems. The leaves are oppositely arranged in pairs but appear whorled owing to the three-parted, palmately compound, finely dissected leaflets. Each leaflet is 3 to 8.5 cm (1.2 to 3.3 in) long. The yellow flower heads are borne at the branch tips singly or in clusters of two, and consist of 8 to 10 ray florets and 20 to 30 disk florets per head. The winged achenes (a type of dry, closed fruit) are 1.8 to 2.6 mm (0.07 to 0.1 in) long (Wagner et al 1999; 56 FR 55770).

Listing Status   *Melanthera tenuifolia* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). This species was formerly classified and listed as *Lipochaeta tenuifolia*. The taxonomic change to *Melanthera tenuifolia* is cited in the "Supplement to the *Manual of the Flowering Plants of Hawaii*" (Wagner and Herbst 2003). The status of *Melanthera tenuifolia* is identical to that of *Lipochaeta tenuifolia*, the federally listed taxon.

These population units are found on Federal and State lands (68 FR 35950). Five of the six existing population units are exceeding minimum numerical criteria for a stabilization population unit (defined as at least 50 mature, reproducing individuals for short-lived perennials).

Survey data of *Melanthera tenuifolia* since it was listed in 1991 indicate significant increases in the total range-wide number of individuals, due in large part to enhanced reproduction and recruitment in managed sites. However, a 25 to 31 percent decrease in overall numbers seems to have occurred since 2003. *Melanthera tenuifolia* reproduces both vegetatively and sexually, and both vegetative clones and seedlings are commonly observed. Vegetative reproduction creates identical adjacent plants, so monitoring results are based on individuals identified as plant material at least 2 m (6.6 ft) apart (U.S. Army 2005b). Plants in the Kahanahaiki, Kaluakauila, Keawaula, and the three Ohikilolo population units are located in zones at risk from training-related wildfire. Thus, *M. tenuifolia* is characterized by six population units, of which five are exceeding minimum numerical criteria for stabilization population, overall increasing trends in numbers since listing and decreasing trends over the short-term since 2003.

<u>Historic and Current Distribution</u> *Melanthera tenuifolia* is endemic to the Hawaiian Islands and it historically occurred in the northern Waianae Mountains of Oahu (68 FR 35950). Currently, *M. tenuifolia* occurs in six population units totaling approximately 3,254 individuals (Table SB 25).

Table SB 25. Range-wide Distribution of *Melanthera tenuifolia*.

Population Units	**Number of Known Individuals**					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kahanahaiki	--	--	300	73/23	54/27	54/27
Kaluakauila	--	--	113	64/20	64/60	64/60
Keawaula	--	--	20/20‡	20/20	45/15	45/15
Ohikilolo*	--	--	1	--	1242/1	1242/1
Ohikilolo Makai*	--	--	8/8	2008/0		
Ohikilolo Mauka*	--	--	2000			
Kamaileunu & Waianae Kai*	--	--	1285-1955	796/269	831/566	880/566
Keaau	--	--	33-43	--	--	--
Mt. Kaala NAR*	--	--	250	250/0	300/0	300/0
Total Individuals	**400-600**	**2000**	**4038-4718**	**3542** (3211/332)†	**3205** (2536/669)	**3254** (2585/669)

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

<u>Ecology</u> *Melanthera tenuifolia* is found in habitats that range from very dry (Ohikilolo Makai subpopulation) to mesic (Mt. Kaala Natural Area Reserve population unit), at elevations of 122 to 914 m (400 to 3,000 ft) (Makua Implementation Team 2003; U.S. Army Garrison 2005b). Most plants occur on north-facing slopes, cliff faces and cliff ledges, and steep rocky ridge sides; or in forest openings vegetated with native shrubs, grasses, and sedges. *Melanthera tenuifolia* flowers for much of the year, mostly in late winter and spring until onset of the summer dry season. The flowers are probably insect-pollinated, as are many yellow-flowered members of the sunflower family. Because *M. tenuifolia* is an herbaceous species, its longevity probably is similar to that of other small plants that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *M. tenuifolia* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, and specific environmental requirements.

Threats to the Species *Melanthera tenuifolia* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Thus, because of its relative overall abundance but ongoing need for stabilization management, *M. tenuifolia* has a moderate background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Melanthera tenuifolia* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Melanthera tenuifolia*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). *Melanthera tenuifolia* in the Mt. Kaala Natural Area Reserve population unit and Kamaileunu and Waianae Kai population unit are being managed for stabilitzation. The eastern part of the Kamaileunu and Waianae Kai population unit is located in an area that will be protected by the Makaha Management Unit fence scheduled for construction in 2007 thru 2009. The Mt. Kaala Natural Area Reserve population unit is not fenced but is regularly controlled for goats (U.S. Army Garrison 2005b). In addition, about 1,367 individuals (42 percent of all remaining individuals) of this species occur in five management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Kaluakauila, Lower Ohikilolo, and Ohikilolo, which are fenced; and Makaha (subunit I) and Manuwai, which are not fenced.

Cuttings of *Melanthera tenuifolia* root easily with moderate success (50 to 75 percent success rate). Vegetative clones of plants from fire-threatened sites are prioritized for greenhouse genetic storage (U.S. Army Garrison 2005b). Seed is difficult to collect because of unpredictable fruiting seasons and site inaccessibility. Although seed from clones appears viable, it does not germinate; research is needed to determine how to overcome seed dormancy for feasible outplanting techniques. Current *ex situ* collections for this species include apical and lateral buds in micropropagation (Harold L. Lyon Arboretum), 13 cuttings in a nursery (Harold L. Lyon Arboretum), three plants in a botanical garden (Waimea Valley Audubon Center), one ungerminated seed in a nursery (Harold L. Lyon Arboretum), and 5,700 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description A total of 209 ha (516 ac) of critical habitat, in three separate units, was designated for *Melanthera tenuifolia* on State lands (Makua-Keaau and Waianae Kai Forest Reserves, and Kaala Natural Area Reserve) on Oahu. Overall, these units provide habitat to support four populations. To meet recovery goals, a population should be represented by at least 50 mature, reproducing individuals of *M. tenuifolia* (68 FR 35950).

The primary constituent elements of critical habitat include ridge tops or bluffs in open areas or protected pockets of dry to mesic forests or shrublands or forests dominated by *Diospyros sandwicensis*, at elevations between 110 and 978 m (361 and 3,208 ft). In addition, all units contain one or more of the following associated native plant species: *Artemisia australis*, *Bidens* sp., *Carex meyenii*, *Diospyros* sp., *Dodonaea viscosa*, *Doryopteris* sp., *Dubautia* sp., *Eragrostis* sp., *Myoporum sandwicense*, *Osteomeles anthyllidifolia*, *Psydrax odorata*, *Reynoldsia sandwicensis*, *Rumex* sp., *Sapindus oahuensis*, *Santalum* sp., or *Schiedea* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Fire has severely degraded habitat in population units on Makua where critical habitat has not been designated; critical habitat within the action area but outside the installation is also threatened by fire.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 47 percent of all known individuals of *Melanthera tenuifolia* are located within the action area, in the Ohikilolo, Kahanahaiki, Kaluakauila, and Keawaula population units (see Table SB 25). All but the Keawaula population units have exceeded minimum numerical criterion for stabilization population units, of at least 50 mature, reproducing individuals for short-lived perennials. However, threats are not controlled and genetic storage goals are not complete, so these population units are not considered fully stabilized (U.S. Army Garrison 2005b). Overall numbers in the Ohikilolo and Kahanahaiki population units have decreased from 2,016 individuals in 2003 to 1,243 in 2005 (Ohikilolo), and from 300 in 2003 to 81 in 2005 (Kahanahaiki). Overall numbers in the Kaluakauila and Keawaula population units have increased from 113 to 124 and from 40 to 60, respectively, during that same time period. Plants in the Kahanahaiki, Kaluakauila, Keawaula, and Ohikilolo population units are located in fire risk zones. Approximately 223 individuals occur in the high fire risk zone, 1,285 individuals in the low fire risk zone. These individuals at risk from fire in the action area represent about 53 percent of the species' total range-wide numbers. The Ohikilolo population unit is located within the Lower Ohikilolo and Ohikilolo management units on Makua, along the steep south wall of Makua valley. The Army has not systematically monitored this population unit, but incidental observations indicate *M. tenuifolia* is returning to habitat where it had been extirpated by goats (U.S. Army Garrison 2005b). The Ohikilolo Makai site contains plants in an extremely dry, low elevation (122 m; 400 ft) that may represent a distinct ecotype (U.S. Army Garrison 2005b). The Kaluakauila population unit is located within the Kaluakauila Management Unit on the north side of Makua Valley on Makua. The Kahanahaiki population unit is located in the C-ridge vicinity of Makua, and the Keawaula population unit is located within the action area north of the installation boundary; these population units are not located within management units. Thus, *M. tenuifolia* in the action area comprises 53 percent of all remaining individuals and is characterized by three population units exceeding minimum numerical criteria for stabilization population units and one population unit near minimum numerical criteria for a stabilization population unit, located within high through the low to very low fire risk zones.

Status of the Critical Habitat in the Action Area The action area contains a total of 67 ha (166 ac), or 32 percent, of the total critical habitat for *Melanthera tenuifolia*. Part of one critical habitat unit is located on State land in the south-central part of the action area. This area is part of a critical habitat unit totaling 67 ha (166 ac) that extends beyond the action area and provides potential habitat to support one population of 300 mature, reproducing individuals, that is currently occupied. Approximately 8 ha (19 ac) of designated critical habitat is in the low fire risk zone and 60 ha (147 ac) are in the very low fire risk zone. About 32 percent of the total critical habitat designated for this species is located in an area at risk from training-related wildfire in the action area. It is estimated that almost all the critical habitat is in areas of less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Melanthera tenuifolia* and its critical habitat in the action area are those described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section and tabulated in Appendix E. *Melanthera tenuifolia* in the action area is especially vulnerable to wildfire from military training activities and damage from feral goats. At Makua, *M. tenuifolia* is restricted to vertical cliffs and is rare in areas that were previously accessible to goats. Fires have burned around *M. tenuifolia* plants and have severely degraded habitat in all action area population units except Keawaula, where *M. tenuifolia* apparently has returned to some of those burned areas (U.S. Army Garrison 2005b). The July 2003 prescribed fire, for example, destroyed five *M. tenuifolia* plants and severely stressed 24 individuals in the Kahanahaiki population unit. This population unit is near other areas in the C-ridge vicinity that have burned in the past and are now dominated by fire-prone alien grasses (U.S. Army Garrison 2003b). No recent information is available on the fate of the 24 fire-stressed plants. However, one year after the 2003 fire, more *M. tenuifolia* plants were present at the site than before the fire, either from new seedlings or re-sprouted from buried stems (U.S. Army Garrison 2005b). About 32 percent of the total critical habitat designated for this species is located in an area at risk from training-related wildfire in the action area, with less than one percent located in the high fire risk zone. Thus, because about 62 percent of all known individuals on Oahu occur within the action area in zones of high to very low fire risk, *M. tenuifolia* in the action area has a high background risk of species extinction, and ongoing efforts are needed to protect it from existing and additional threats to its long-term persistence.

<u>Conservation Needs of the Species and Critical Habitat in the Action Area</u> The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Melanthera tenuifolia* because threats have not been controlled in the three stabilization population units and full genetic storage is not complete. Three population units have been identified for stabilization of *M. tenuifolia*: Ohikilolo within the action area, and Kamaileunu-and-Waianae-Kai and Mt. Kaala Natural Area Reserve outside the action area. Army Natural Resources Staff expect no augmentation will be necessary to achieve stabilization at any of the stabilization population units (U.S. Army Garrison 2005b). Post-fire revegetation plans and site-specific fuels modification are needed for all population units located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the “Status and Environmental Baseline of the Species and Critical Habitat” section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area</u> The four population units in the action area contain 46 percent of the total remaining individuals of *Melanthera tenuifolia*. The Ohikilolo population unit is being managed for stabilization as

specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). Within the installation, the Army has fenced the top of Ohikilolo ridge. The habitat located outside of the installation boundary near the Ohikilolo Management Unit is steep and does not require fencing. The low elevation Makai plants outside the boundary fence are protected by a strategic fence. This species occurs in the Kaluakauila, Lower Ohikilolo, and Ohikilolo management units within the action area, all of which are fenced, and goats have been virtually eradicated from Makua. The Kaluakauila population unit also is protected by a management unit pig exclosure fence and by grass control within forest patches to minimize the spread of fire. About 42 percent of the critical habitat in the action area is within fenced management units. Genetic storage goals for *M. tenuifolia* are seven percent complete, with 21 plants from all six population units combined meeting the goals of the Makua Implementation Plan. There are currently 73 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Critical Habitat – *Melicope pallida* (Alani)

Critical Habitat Description A total of 1,774 ha (4,385 ac) of critical habitat was designated for *Melicope pallida* in seven separate units on Kauai and Oahu. Five critical habitat units were designated on Oahu encompassing 1,321 ha (3,265 ac). Each unit provides habitat for one or more populations, each comprised of at least 100 mature, reproducing individuals of *M. pallida*. One unit on Oahu provides habitat for three populations, one unit provides habitat for one population, and two units combined will provide habitat for one population of *M. pallida*. Critical habitat has been designated on Federal (Lualualei Naval Reservation on Oahu), State (Alakai Wilderness Preserve and Na Pali Coast State Park on Kauai; Mokuleia Forest Reserve, Kaala and Pahole Natural Area Reserves on Oahu) and private (Honouliuli Preserve) lands (68 FR 9116; 68 FR 35950).

The primary constituent elements of these units include steep rock faces in lowland dry or mesic forests and containing one or more of the following associated native plant species: *Abutilon sandwicense*, *Acacia koa*, *Alyxia oliviformis*, *Bobea elatior*, *Cibotium* sp., *Dryopteris* sp., *Metrosideros polymorpha*, *Pipturus albidus*, *Psychotria mariniana*, *Sapindus oahuensis*, *Syzygium sandwicensis*, *Tetraplasandra* sp., *Wikstroemia oahuensis*, or *Xylosma hawaiiense*, and elevations between 234 to 841 m (768 to 2,758 ft). The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels that are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat include the black twig borer, the Chinese rose beetle, wildfire, habitat degradation by feral pigs and non-native plants, and stochastic events (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Two percent (28 ha; 69 ac) of the designated critical habitat for *Melicope pallida* is located in one unit within the northeastern portion of the Makua action area in an area of low fire risk. This portion of the critical critical habitat unit within the action area along with 826 ha (2,042 ac) outside of the action area provides habitat for the conservation of three populations of *M. pallida*. It is estimated that more than one-half of the critical habitat is in an area with less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Critical Habitat in the Action Area The major threats to the primary constituent elements of the critical habitat include the black twig borer, fire from military training activities, habitat degradation by feral pigs, and stochastic events. Non-native plants, especially *Andropogon virginicus*, *Clidemia hirta*, *Psidium cattleianum*, *Pterolepis glomerata*, and *Toona ciliata*, compete with associated native plants for light, space, and nutrients. In addition, predation of associated native plants by rats, slugs and the Chinese rose beetle threaten critical habitat (68 FR 35950).

Ongoing Conservation Actions for the Critical Habitat Within the Action Area Sixty-eight percent (19 ha; 47 ac) of the critical habitat in the action area is in Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha Management Units. The Army currently controls non-native plant species in the West Makaleha Management Unit. Construction of additional fence exclosures is planned for the Upper Kapuna and West Makaleha Management Units (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Neraudia angulata* (No Common Name)

Species Description *Neraudia angulata* is a short-lived shrub in the Urticaceae (nettle family). It is an upright shrub up to 3 m (9.8 ft) tall with alternately arranged leaves 7 to 15 cm (2.7 to 5.9 in) long. The undersides of the leaves are usually covered with hairs, and the leaf margins are sometimes toothed. The flowers are borne in axillary clusters, and the species is dioecious (with male and female flowers on separate plants). Many cultivated plants, however, have both male and female flowers (Makua Implementation Team 2003). The mature fruit is small and seed-like, and is enclosed in a red, fleshy calyx (Wagner et al 1999).

The taxonomy of *Neraudia angulata* is in need of further study. There are two recognized varieties of *N. angulata*: var. *angulata* and var. *dentata*. Variety *angulata* is characterized by leaf undersides with hairs lying close to the leaf surface in a silvery sheen, and by leaf margins that are not toothed. Variety *dentata* has leaf undersides with hairs projecting out from the leaf surface, and some plants have some leaves with toothed leaf margins. The two varieties reportedly can be found growing near one another, yet remain distinct entities. Occurrences also have been found that apparently do not represent either strict var. *dentata* or strict var. *angulata* (Makua Implementation Team 2003).

Listing Status *Neraudia angulata* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). Both varieties of *N. angulata* are included in the listed taxon.

Historic and Current Distribution The genus *Neraudia* is endemic to the Hawaiian Islands. Historic data indicate *Neraudia angulata* occurred throughout the Waianae Mountains of Oahu

(56 FR 55770). Assessment of long-term population trends is difficult because of the tendency of *N. angulata* occurrences to fluctuate in size and it has only been monitored with any diligence since 2003. When the species was listed in 1991, only five occurrences totaling 15 individuals were known. Since then, more occurrences have been discovered, but the number of sites was still thought to be diminishing in 2003 (Makua Implementation Team 2003). With the initiation of intensive population unit and habitat management in 2003, numbers of individuals have increased. Currently, *N. angulata* occurs in nine population units totaling approximately 380 individuals (Table SB 26). These population units are found on Federal, State, city/county, and private lands (68 FR 35950). None of the existing population units has met minimum numerical criteria for stabilization (defined for this species as at least 100 mature, reproducing individuals). Occurrences of *N. angulata* var. *dentata* are found in the Kapuna population unit, and were formerly found in the Manuwai population unit (all individuals within the Manuwai population unit are now dead; U.S. Army Garrison 2006c). In addition, a new occurrence of one var. *dentata* plant was discovered at Punapohaku on Makua, and is the only known leeward Waianae plant of this variety (U.S. Army Garrison 2005b).

Since consistent monitoring efforts began in 2003, three population units have increased in numbers, five have decreased or remained nearly the same, and one has disappeared. The most robust population units of *Neraudia angulata* are at Waianae Kai Makai and Waianane Kai Mauka, on State land. However, the apparent increases in these population units are due to discovery of plants in new areas htrough more diligent survey efforts (U.S. Army Garrison 2005b). The Makua population unit has increased due to habitat protection and population augmentation. The Halona and Makaha population units have decreased substantially. These decreases have occurred in the number of both mature and immature plants. In general, *N. angulata* tends to experience large declines or fluctuations in population size. Plants in the Kaluakauila, Makua, and Punapohaku population units are located in high and low risk fire zones for training-related wildfire. Thus, *N. angulata* is characterized by low numbers in nine population units not meeting minimum numerical criterion for stabilization, an overall increase in abundance due primarily to discovery of new individuals and augmentation, and population unit individual numbers that range from increasing to decreasing to little change.

Table SB 26. Range-wide Distribution of *Neraudia angulata*.

Population Units	Numbers of Known Individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kalauakauila*	--	--	--	--	0/0 [13/0]	0/0 [27/0]
Kapuna	--	--	1/0‡	1/0	1/0	2/0
Makua*	--	--	29/2	12/61 [0/20]§	14/67 [15/19]	40/6 [4/0]
Punapohaku	--	--	--	--	1/0	1/0
Halona	--	--	15/0	15/0	8/0	30/4
Leeward Puu Kaua	--	--	3/0	2/0	3/0	4/0
Makaha	--	--	56/14	7/4	16/1	16/1
Manuwai*	--	--	12/0	0/2	1/0	0/0

Waianae Kai Makai	--	--	4/0	46/35	46/35	46/60
Waianae Kai Mauka*	--	--	21/25	49/4	49/54	57/82
Total Individuals	**15**	**110**	**182** (141/41)†	**258** (132/106) [0/20]	**343** (139/157) [28/19]	**380** (196/153) [31/0]

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Neraudia angulata* is found in dry forests and shrublands, and occasionally in mesic forests and shrublands, at elevations of 189 to 978 m (620 to 3,208 ft) (Makua Implementation Team 2003; 68 FR 35950). Plants occur on gulch slopes, on steep to nearly vertical cliffs and cliff ledges, in the forest understory, and among shrubs and grasses in exposed areas (Makua Implementation Team 2003). Plants may lose all their leaves during the dry summer months (U.S. Army Garrison 2005b). *Neraudia* species are wind-pollinated (Wagner *et al* 1999), and flowering and fruiting occur throughout the year. The red, fleshy calyx surrounding the mature fruit suggests that fruit-eating birds may disperse the seeds. The longevity of *N. angulata* is probably similar to that of other small shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). This dioecious species is subject to large declines or fluctuations in population size. Other demographic information for *N. angulata* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Neraudia angulata* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. This species is particularly threatened by fire. In addition, occurrences of *N. angulata* are vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a; Service 1998a). *Neraudia angulata* tends to fluctuate widely in population size, and any catastrophic disturbance during a major low point could extirpate one or more population units or result in the extinction of the species in the wild (Makua Implementation Team 2003). Thus, *N. angulata* has a very high background risk of species extinction and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Neraudia angulata* are described in the introduction to the "Status and

Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998). At least 50 mature, reproducing individuals are needed per population unit to attain stability for short-lived perennials. However, species subject to common, large fluctuations in numbers may require a stabilization target of at least 100 mature individuals for each population unit. The minimum population size was increased for this species also because fertilization and seed set of dioecious plants require more reproducing individuals of both male and female plants within pollination range that are flowering at the same time (Makua Implementation Team 2003).

All varieties of *Neraudia angulata* should be, and are being, conserved in the wild. The Kapuna and Punapohaku (and formerly the Manuwai) population units contain plants of var. *dentata* (U.S. Army Garrison 2005b). Because the habitat at these sites is degraded by ungulates and invasive weeds, this stock will be used to reintroduce plants in appropriate habitat in the Kaluakauila Management Unit on Makua. The Makaha and Waianae Kai population units contain stock that is intermediate between var. *angulata* and var. *dentata*. If pure var. *angulata* plants are found, the Army recommends that a fourth population unit be managed for stabilization to conserve that variety (U.S. Army Garrison 2005b). However, because the taxonomy of *N. angulata* is still not well understood, outplanting must proceed with caution to avoid compromising the genetic integrity of the varieties, populations, and potential ecotypes currently included within *N. angulata* (Makua Implementation Team 2003).

<u>Ongoing Conservation Actions</u> The Makua Implementation Team (2003) has developed stabilization protocols for *Neraudia angulata*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Four population units of *N. angulata* are being managed for stabilization. In addition, individuals of this species occur in four management units where they will benefit from population unit and/or ecosystem-level protection. The management units include the Kaluakauila and Ohikilolo Management Units, which are fenced; and the Makaha and Waianae Kai Management Units, which are not fenced.

Seed is difficult to collect from *Neraudia angulata* because plants produce few mature fruits at a time and take many months to mature. Both fresh and stored seed have low viability and germination rates (U.S. Army Garrison 2005b). Because appropriate genetic storage treatments are unknown, living collections probably should be maintained as potted plants from nursery cuttings. In 2005, *ex situ* collections for this species included 15 plants in a botanical garden (Waimea Valley Audubon Center), and 8,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

<u>Critical Habitat Description</u> A total of 544 ha (1,344 ac) of critical habitat, in six separate units, was designated for *Neraudia angulata* on Oahu. Critical habitat was designated on Federal land (Lualualei Naval Reservation), State lands (Kaena State Park, Pahole Natural Area Reserve, and Kuaokala, Mokuleia, and Waianae Kai Forest Reserves), and private lands. Overall, these six units provide habitat to support seven populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *N. angulata* (68 FR 35950).

The primary constituent elements of these units include slopes, ledges, or gulches in lowland mesic or dry forest at elevations between 134 and 881 m (440 and 2,890 ft). In addition, all units contain one or more of the following associated native plant species: *Artemisia australis*, *Bidens* sp., *Carex meyenii*, *Diospyros* sp., *Dodonaea viscosa*, *Hibiscus* sp., *Nestegis sandwicensis*, *Pisonia sandwicensis*, *Psydrax odorata*, or *Sida fallax*. Units on cliffs, rock embankments, gulches, or slopes in mesic or dry forests contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma pulvinatum*, *Artemisia australis*, *Bidens torta*, *Canavalia* sp., *Carex* sp., *Charpentiera* sp., *Diospyros hillebrandii*, *D. sandwicensis*, *Dodonaea viscosa*, *Eragrostis* sp., *Hibiscus* sp., *Metrosideros polymorpha*, *Myrsine lanaiensis*, *Nestegis sandwicensis*, *Pisonia* sp., *Psydrax odorata*, *Rauvolfia sandwicensis*, *Sapindus oahuensis*, *Sida fallax*, or *Streblus pendulinus*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat See introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species

Status of the Species in the Action Area About 80 individuals, or 21 percent of all known individuals of *Neraudia angulata*, are located within the action area in the Makua, Kaluakauila, Kapuna, and Punapohaku population units (see Table SB 26). None of these population units have met numerical criteria for a stabilization of at least 100 mature, reproducing individuals. The Kaluakauila population unit has recently been established through reintroduction, and the one plant in the Punapohaku population unit was only recently discovered; these population units are not considered to be critically important to the stabilization of *N. angulata*. Stock from var. *dentata* plants at the windward Waianae Kapuna and Manuwai population units, and from the leeward Waianae Punapohaku population unit, will be used for additional reintroductions in the Kaluakauila Management Unit (U.S. Army Garrison 2005b). Since 2003, Army Natural Resources Staff have reintroduced 27 plants into Kaluakauila and augmented the Makua population unit with about 50 plants grown from cuttings. As of 2005, survivorship had been 100 percent at Kaluakauila and 80 percent at Makua (U.S. Army Garrison 2005b). Plants in the Kaluakauila, Kapuna, Makua, and Punapohaku population units are located in high and low fire risk zones. About 32 individuals occur in the high fire risk zone and 48 in the very low fire risk zone. The individuals in the high fire risk zone represent about eight percent of the species' total range-wide numbers.

The Makua population unit is located within the Ohikilolo Management Unit on Makua, along the steep south wall of Makua valley. Vegetation in the Ohikilolo Management Unit consists of native dry cliff communities, ridgetop mesic native shrubland dominated in some areas by *Dodonaea* and *Metrosideros* species, and areas of *Pritchardia kaalae* Lowland Mesic Forest, a rare natural community. The Kaluakauila population unit has been established in the Kaluakauila Management Unit, along the north side of the installation. Vegetation in the Kaluakauila Management Unit consists of dry, alien grasslands and shrublands with patches of native lowland dry forest (U.S. Army Garrison 2005a). The recently discovered Punapohaku population unit is located in a gulch along the steep rim of the northern boundary of Makua.

This population unit is not located within a management unit, and habitat is degraded by ungulates and invasive weeds (U.S. Army Garrison 2003b). Thus, *N. angulata* in the action area comprises 21 percent of all remaining individuals and is characterized by four population units not meeting numerical criterion for stabilization, including one population unit within the high fire risk zone that is increasing due to habitat protection and augmentation.

<u>Status of the Critical Habitat in the Action Area</u> The action area contains a minimal fragment, or one percent (6.1 ha, 15.0 ac) of the total critical habitat designated for *Neraudia angulata*. Critical habitat in the action area occurs as parts of two larger units which combined contain 89.8 ha (221.9 ac) in the southwestern portion of the action area. This fragment of critical habitat is located in the very low fire risk zone and is considered to have minimal existing conservation value for the species because of unabated non-native threats.

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Neraudia angulata* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Neraudia angulata* in the action area is especially vulnerable to wildfire resulting from military training activities. Fires have already destroyed or damaged portions of *N. angulata* habitat within the action area, particularly in the Kaluakauila and Kahanahaiki areas of Makua (Makua Implementation Team 2003). The July 2003 prescribed fire, for example, destroyed about 2.4 ha (6 ac) of *N. angulata* critical habitat on State land in the Kaluakauila Management Unit outside the installation boundary. About one percent of the total critical habitat designated for this species is located in an area at very low risk of training-related wildfire. Thus, because about 21 percent of all known individuals occur within the action area in areas at risk of training-related wildfire, with eight percent of all known individuals at high risk, and the small, overall population is subject to fluctuation, *N. angulata* in the action area has a very high background risk of species extinction and any additional threats could reduce expectation of its long-term persistence.

<u>Conservation Needs of the Species in the Action Area</u> The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Neraudia angulata* because there are no population units meeting numerical criterion for stabilization outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Four population units have been identified for expedited stabilization of *N. angulata*: Kaluakauila and Makua within the action area, and Manuwai and Wainae Kai Mauka outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed in locations where this species is located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. Strategic fencing is needed to protect the plant at Punapohaku. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species in the Action Area</u> The four population units in the action area contain 21 percent of the total remaining individuals of *Neraudia angulata*. The Kaluakauila and Makua population units within the action area contain 20 percent of the total remaining individuals and are being managed for stabilization as specified by the Army's Makua

Implementation Plan Addendum (U.S. Army Garrison species). The Makua population unit is located within the Okikilolo Management Unit, most of which is protected by a boundary ridgeline fence, and goats have been virtually eradicated from Makua. The Kaluakauila Management Unit is fenced and non-native ungulates and invasive weeds are controlled (U.S. Army Garrison 2005a). In addition, fuels modification along the Kaluakauila ridgeline reduces the risk of fire in that management unit (K. Kawelo, pers. comm. 2004; Service 2004a). The Kaluakauila population unit also is protected by a management unit pig-exclosure fence, rat control, and grass control within forest patches to minimize the spread of fire. A total of about 37.8 ha (93.8 ac) of critical habitat for this species is located within management units both within and outside of the action area (Kaimuhole, Makaha, Manuwai, Palikea, Upper Kapuna). Only about 2.0 ha (4.9 ac) of the total critical habitat that is within management units is located inside the action area (Upper Kapuna Management Unit). As of 2005, genetic storage goals for *N. angulata* were three percent complete, with 12 plants from all nine population units combined meeting the goals of the Makua Implementation Plan, and there were 43 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Notrichium humile* (Kulu i)

Species Description *Nototrichium humile* is a long-lived perennial shrub in the Amaranthaceae (amaranth) family. It is a basal-branching shrub 1 to 2 m (3.3 to 6.6 ft) tall, with upright or arching branches. The green, ovate to oblong leaves are 3 to 9 cm (1.2 to 3.5 in) long, and lack the silvery hairs characteristic of the other two *Nototrichium* species. The flowers are borne in slender, terminal spikes 3 to 14 cm (1.2 to 5.5 in) long. The perfect flowers (with both male and female reproductive parts) are small and inconspicuous, and the dry fruits are not much larger (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Nototrichium humile* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for this species was designated on June 17, 2003, for Oahu (68 FR 35950) and on May 14, 2003, for Maui (68 FR 25934).

Historic and Current Distribution *Nototrichium* is a genus endemic to the Hawaiian Islands. Historically it occurred throughout the Waianae Mountains of Oahu and on East Maui (56 FR 55770, 68 FR 25934). The status of *N. humile* on Maui is uncertain as no reports have been documented since 1979 (68 FR 25934). When the species was listed in 1991, 11 occurrences were estimated to contain up to 3,000 individuals on Oahu. Since then, 16 population units have been identified with a total of about 1,296 individuals. These population units are found on Federal, State, and city/county lands (68 FR 35950). No information is available on the current existence or numbers of *N. humile* on Maui.

Trends in numbers indicate declines of *Nototrichium humile* since 1991, when consistent monitoring was initiated (Table SB 27), followed by an increase in 2004. All but two of the 16 population units have decreased or remained about the same, though the increases in two of the population units are sizable. Overall, numbers have decreased by about 20 percent, but current numbers have increased to roughly the 2003 levels. Seven of the population units are have exceeded minimum numerical criterion for stabilization population units (defined as at least 25 mature, reproducing individuals for long-lived perennials). Plants in the Kahanahaiki, Kaluakauila, Keaau, Keawaula, Punapohaku, and the two Makua population units are located in zones at risk from training-related wildfire. Thus, *N. humile* is characterized by 16 population units, of which seven have exceeded minimum numerical criteria for stabilization population units; overall trends in numbers have increased since 2004 after initially falling in 1991.

Table SB 27. Range-wide Distribution of *Notrichium humile*.

Population Units	**Number of Known Individuals**					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kahanahaiki	--	--	140	32/2	34/0	34/0
Kalauakauila*	--	--	200-400	200/0	198/35	198/35
Keaau	--	--	21/31‡	21/31	21/31	21/31
Keawaula	--	--	200/30	200/30	138/5	138/5
Makua (east rim)	--	--	1	1/0	0/0	0/0
Makua* (south side)	--	--	120-140	56/1	56/19	56/1 [16/0]§
Punapohaku	--	--	--	152/14	302/21	302/21
Kaimuhole & Palikea Gulch (Kihakapu)*	--	--	48/6	8/3	58/7	58/7
Kealia	--	--	3	3/0	3/0	0/0
Keawapilau	--	--	9/1	5/0	5/0	5/0
Kolekole (east side)	--	--	13	13/0	12/0	12/0
Makaha*	--	--	159	159/0	16/3	16/3
Nanakuli	--	--	5	5/0	5/0	5/0
Puu Kaua (leeward)	--	--	12	12/0	12/0	12/0
Waianae Kai*	--	--	200-320	200/0	224/5	224/5
Lualailua, Maui	--	--	--	--	--	--
Other Surveyed Locations						6/45
Total Individuals	**1500-3000**	**1489-1610**	**1199-1539**	**1148** (1067/81)†	**1210** (1084/126)	**1256** (1087/153) [16/0]

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduded]

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c), Army 2006 database (U.S. Army Garrison 2006d)

Ecology *Nototrichium humile* is found on gulch slopes and gulch bottoms in the understory of dry forests dominated by *Diospyros sandwicensis* or *Sapindus oahuensis*, dry shrublands near ridge tops, and open dry cliffs and cliff ledges sparsely vegetated with shrubs and grasses. Small groups or isolated plants sometimes occur in mesic habitats. On cliffs, *N. humile* is somewhat protected from feral ungulates, invasive alien weeds, and fire. This species usually is found on north-facing slopes at elevations of 60 to 700 m (197 to 2,298 ft) (Makua Implementation Team 2003). Flowering in *N. humile* is generally heaviest in the spring and summer, and the fruits mature a few weeks after flowering. Pollination vectors for this species are not known, nor is it known if the plants are self-compatible. Based on observations of particular individuals, the plants live for at least one or two decades (Makua Implementation Team 2003). Other demographic information for *N. humile* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Nototrichium humile* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. This species is one of the more fire-endangered species at Makua because of its occurrence in the lower, drier reaches of the Waianae Mountains (Makua Implementation Team 2003). Thus, although almost half of its 16 population units have exceeded minimum numerical criteria for stabilization population units, *N. humile* has a high background risk of species extinction, and ongoing stabilization management is needed to protect it from existing and additional threats and ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Nototrichium humile* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Nototrichium humile*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Four population units of *N. humile* are being managed for stabilization. In addition, about 693 individuals (approximately 53 percent of all remaining individuals) of this species occur in six management units where they will benefit from population unit and/or ecosystem-level protection. The management units include the Kahanahaiki, Kaluakauila, and Ohikilolo, which are fenced; and the Kaimuhole, Makaha, and Waianae Kai Management Units, which are not fenced.

Seed collection from *Nototrichium humile* is difficult and germination rates are very low; most fruit tested have no seeds. A major part of genetic storage is maintained in the greenhouse from cuttings, which have a 70 percent success rate (U.S. Army Garrison 2005b). Current *ex situ* collections for this species include 384 cuttings in a nursery (Army Environmental Division, Oahu), 10 plants in botanical gardens (Amy Greenwell Ethnobotanical Garden and Waimea

Valley Audubon Center), and 3,700 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description   A total of 900 ha (2,224 ac) of critical habitat, in five separate units, was designated for *Nototrichium humile* on Oahu and Maui. On Oahu, 502 ha (1,241 ac) of critical habitat was designated in four units on State lands (Kaena State Park, Pahole Natural Area Reserve, and Kuaokala, Mokuleia, and Waianae Kai Forest Reserves), and on private lands. Overall, the four units on Oahu provide habitat to support six populations. On Maui, one unit on State and private lands was designated to provide habitat for one population. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *N. humile* (68 FR 35950).

The primary constituent elements of critical units on Oahu include cliff faces, gulches, stream banks, or steep slopes in dry or mesic forests often dominated by *Diospyros sandwicensis* or *Sapindus oahuensis,* at elevations between 185 and 806 m (607 and 2,644 ft). In addition, all Oahu units contain one or more of the following associated native plant species: *Abutilon sandwicense*, *Alyxia oliviformis*, *Antidesma pulvinatum*, *Artemisia australis*, *Bidens cervicata*, *Canavalia* sp., *Carex wahuensis*, *Charpentiera* sp., *Dodonaea viscosa*, *Elaeocarpus bifidus*, *Erythrina sandwicensis*, *Eugenia reinwardtiana*, *Hibiscus* sp., *Melanthera tenuis*, *Metrosideros polymorpha*, *Myoporum sandwicense*, *Myrsine lanaiensis*, *Nestegis sandwicensis*, *Peperomia* sp., *Pisonia umbellifera*, *Pleomele* sp., *Pouteria sandwicensis*, *Psydrax odorata*, *Rauvolfia sandwicensis*, *Reynoldsia sandwicensis*, *Sicyos* sp., *Stenogyne* sp., *Streblus pendulinus*, or *Syzygium sandwicensis*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat   See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area   About 858 individuals, or 68 percent of all known individuals of *Nototrichium humile*, are located within the action area in seven population units (see Table SB 27). Five of these action area population units have exceeded minimum numerical criteria for a stabilization population (at least 25 mature, reproducing individuals). Four population units (including three that have exceeded minimum numerical criteria for a stabilization population) have declined in numbers since 2003, and two population units have more or less maintained their numbers. Only the Punapohaku population unit has increased in numbers since 2004, since it was first discovered. The Kaluakauila population unit is located within the Kaluakauila Management Unit, the Makua population units are located within the Ohikilolo Management Unit, and the Kahanahaiki population unit is located within the Kahanahaiki Management Unit; these three management units are fenced. Survivorship of 18 augmented plants in the Makua population unit is about 83 percent so far (U.S. Army Garrison 2005b). The Kahanahaiki, Keaau, Keawaula, and Punapohaku population units are not located within management units or fences. All action area individuals are located in fire risk zones. About 566 individuals occur in the high fire risk zone, 193 individuals occur in the low fire risk zone and 139 in the very low risk zone. Thus, *N. humile* in the action area consists of approximately 70 percent of the total remaining individuals of this species and occurs in seven population units, five of which have exceeded minimum numerical criteria for a stabilization population and four (including three of the stabilization population units) of which are declining in numbers, with the majority (44 percent) within the high fire risk zone.

<u>Status of the Critical Habitat in the Action Area</u> The action area contains a total of about 6 ha (16 ac) or slightly more than one percent of the total critical habitat for *Nototrichium humile* on Oahu, or slightly less than one percent of the State-wide total. Critical habitat is located within one unit in the northwestern part of the action area (within the Kaluakauila Management Unit) in an area of high fire risk. This area is part of a critical habitat unit totaling 5 ha (13 ac) that extends beyond the action area and provides habitat for one population of 300 mature, reproducing individuals. There is less than one percent of another 1 ha (3 ac) critical habitat unit that all falls within the action area. This unit is in the very low fire risk zone.

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Nototrichium humile* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Nototrichium humile* in the action area is especially vulnerable to wildfire resulting from military training activities. Fires have already destroyed or damaged portions of *N. humile* habitat within the action area. The July 2003 prescribed fire, for example, burned about 2.4 ha (6 ac) of *N. humile* critical habitat on State land in the Kaluakauila population unit, and about five plants were destroyed in the Punapohaku population unit. The fire also burned to within 40 m (131 ft) of *N. humile* plants on C-Ridge (U.S. Army Garrison 2003b). About two percent of the total State-wide critical habitat for this species is located in fire risk zones in the action area. Thus, because about 80 percent of all known individuals occur within the action area in zones of high to low fire risk, *N. humile* in the action area has a high background risk of species extinction, and major effort is needed to protect it from existing and any additional threats to its long-term persistence.

<u>Conservation Needs of the Species and Critical Habitat in the Action Area</u> The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Nototrichium humile* because more than 50 percent of the total remaining individuals are located within the action area. Four population units have been identified for stabilization of *N. humile*: Kaluakauila and Makua (south side) in the action area, and Kaimuhole and Palikea Gulch and Waianae Kai outside the action area. Although there are five stabilization populations which exceed minimum numerical criteria within the action area and two outside the action area, stabilization is not achieved because threats are not controlled and genetic storage goals are not complete. The Army does not expect to augment stabilization population units because of relatively high existing numbers of mature individuals (U.S. Army Garrison 2005b). Post-fire revegetation plans and site-specific fuels modification are needed where this species is located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. In the action area, approximately 205 individuals of *N. humile* are in fenced units and 600 individuals are not in fenced units. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area</u> The seven population units in the action area contain approximately 70 percent of the total remaining individuals of *Nototrichium humile*. The Kaluakauila and Makua (south side) population units within the action area are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). In addition, population units are located within the fenced Kahanahaiki, Kaluakauila, and Ohikilolo Management Units (the Makua south-side population unit is located within the Ohikilolo Management Unit). Goats have been virtually eradicated from Makua in general (U.S. Army Garrison 2005b). The Kaluakauila population unit also is protected by a management unit pig exclosure fence and by grass control within forest patches to minimize the spread of fire. In addition, fuels are controlled along the ridgeline between the management unit and the installation boundary to form a fuelbreak (Service 2004). Genetic storage goals for *N. humile* are under one percent complete, with 48 plants from all 16 population units combined not yet meeting the goals of the Makua Implementation Plan. There are also currently 65 plants growing in the Army nursery (U.S. Army Garrison 2005b). Priority Army greenhouse space for this species is for plants from fire-threatened population units.

Status of the Species – *Peucedanum sandwicense* (Makou)

<u>Species Description</u> *Peucedanum sandwicense*, a short-lived perennial and member of the Apiaceae (parsley) family, is a parsley-scented, sprawling herb. Hollow stems arise from a short, vertical, perennial stem with several fleshy roots. The compound leaves are generally three-parted with stalkless leaflets, each egg- or lance-shaped and toothed. The larger terminal leaflet is usually one- to three-lobed and 7 to 13 cm (2.8 to 5.1 inches) long. The other leaflets have leaf stalks 10 to 50-cm (4 to 20 inches) long or are stalkless. Flowers are clustered in a compound umbel of 10 to 20 flowers. The round petals are white and bent inward at the tips. The flat, dry, oval fruits are 10 to 13 mm (0.4 to 0.5 inches) long and 5 to 8-mm (0.2 to 0.3 inches) wide, splitting in half to release a single flat seed. This species differs from the other Kauai members of the parsley family in having larger fruit and pinnately compound leaves with broad leaflets. This species is the only member of the genus on the Hawaiian Islands (Wagner et al 1999).

<u>Listing Status</u> *Peucedanum sandwicense* was federally listed as threatened on February 25, 1994, and State listed as threatened in Hawaii at the same time. A recovery plan was prepared for this species in September 1995 (Service 1995b). Critical habitat was designated in 2003 on Kauai, Molokai, Maui, and Oahu (68 FR 9115; 68 FR 12982; 68 FR 25934; 68 FR 35950).

<u>Historic and Current Distribution</u> Historically, *Peucedanum sandwicense* is known from Molokai, Maui, and Kauai, and discoveries in 1990 extended the known distribution of this species to Oahu. Currently there are a total of 1,000 to 5,000 individuals in 18 occurrences. On Oahu, there are roughly 100 individuals in four occurrences on State, city, and county lands in Keaau Valley, Puu Kawiwi, Waianae Kai, and Kamaileunu Ridge. One occurrence of 20 to 30 individuals is known from State-owned Keopuka Rock, an islet off the coast of Maui. On Molokai, three occurrences totaling fewer than 30 individuals are found on private and State-owned land in Pelekunu Preserve, Kalaupapa National Historical Park, and Huelo, an islet off the

coast of Molokai. The 10 Kauai occurrences are distributed in Waimea Canyon and along the Na Pali Coast within 2.4 km (1.5 mi) of the ocean (Service 1999b; 68 FR 35950). It is also difficult to assess changes in the abundance *P. sandwicense*. However, the total number of individuals on Oahu appears to be relatively stable from the time the species range-wide abundance was first estimated in 1991. Similarly, the overall number of individuals of this species appears to relatively stable on the other islands where it occurs (Maui, Molokia and Kauai) (Table SB 28).

Table SB 28. Range-wide Distribution *Peucedanum sandwicense.*

Occurrences	**Number of Known Individuals**					
	1991 (1)	**1995** (2)	**1999** (3)	**2003** (4)	**2005** (5)	**2006** (6)
Keaau	--	--	20	--	24	--
Waianae Kai	85	85	79	51	79	16/5‡
Total Population Units on Oahu	1	2	2	4	2	1
Total Individuals on Oahu	**85**	**85**	**99**	**51**	**103**	**21** (16/5)†
Total Population Units State-wide	21	16	16	--	21	--
Total Individuals State-wide	**265-355**	**1000-5000**	**1000-5000**	--	**1153-5163**	--

Shaded occurrences are inside the action area.
‡Mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR 55770)
(2) Waianae and Kauai Recovery Plan (Service 1995a, 1995b)
(3) Makua Endangered Species Mitigation Plan (Service 1999b)
(4) Critical habitat rule (68 FR 35950)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

<u>Ecology</u> *Peucedanum sandwicense* grows in cliff habitats from sea level to above 900 m (3,000 ft) and is associated with native species such as *Artemisia australis, Chamaesyce* sp., *Diospyros sandwicensis, Eragrostis variabilis*, and *Metrosideros polymorpha*. Little is known about the life history of *P. sandwicense*. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1999b).

<u>Threats to the species</u> *Peucedanum sandwicense* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The primary threats to *P. sandwicense* are habitat degradation and browsing by feral ungulates, trampling by hikers and landslides. Non-native plants compete with *P. sandwicense* for light, space, and nutrients (U.S. Army Garrison 2005c). Based on the fact

there are only a very few individuals remaining on the island of Oahu, *P. sandwicense* has a high background risk of extirpation from the island of Oahu and any additional threats could reduce expectation of its long-term persistence on the island. However, there is only a moderate risk of background extinction for this species State-wide as there are several thousand individuals on Kauai.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Peucedanum sandwicense* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *P. sandwicense* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua and Schofield Barracks action areas (Service 2003a). The recovery plan for this species identifies several important conservation actions including fencing, weed control, maintenance of adequate genetic material and outplanting of local genetic material (Service 1995b).

Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Peucedanum sandwicense*. This plan will also include broader landscape actions that are needed for the recovery of this species throughout its range (Hawaii and Pacific Plants Recovery Coordinating Committee 2007). Plants and seeds of *P. sandwicense* are currently held at the following institutions: Harold L. Lyon Arboretum, Pahole Mid-Elevation Rare Plant Facility, and the Waimea Arboretum. The Service is unaware of any other specific conservation actions for this species (Service 1999b; L. Durand, pers. comm. 2004).

Environmental Baseline of the Species

Status of the Species in the Action Area There are approximately 25 individuals *Peucedanum sandwicense* within the Makua action area. However, the exact number is not known because the Army does not actively monitor this species. *Peucedanum sandwicense* is a short-lived perennial herb and fluctuations in abundance are normal. Variation in rainfall along with other abiotic and biotic factors may account for these fluctuations. Furthermore, seeds of *P. sandwicense* may persist in the seed bank and there may be a reoccurrences of this species within the action area when there are more suitable environmental conditions.

Threats to the Species The primary threats to *Peucedanum sandwicense* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E.

Conservation Needs of the Species and Critical Habitat in the Action Area Pursuant to the guidelines established in the Makua Implementation Plan, *Peucedanum sandwicense* will not be stabilized. There are thousands of individuals outside of the action area. There most robust populations are located on the island of Kauai where there are thought to be between 1,000 and 5,000 individuals of this species. This species will benefit from additional conservation actions such as fencing, ungulate removal, reduction of non-native plant species, and control of wildfires (Service 1999b).

Ongoing Conservation Actions for the Species There is no species specific conservation action for this species in the action area.

Status of the Species and Critical Habitat – *Phyllostegia kaalaensis* (No Common Name)

Species Description *Phyllostegia kaalaensis* is a short-lived perennial herbaceous plant in the Lamiaceae (mint family). It has long stems extending from the base of the plant with oppositely arranged leaves 5 to 13 cm (2.0 to 5.1 in) long. Inflorescences are borne at the stem tips on stalks with nodes of 3 to 6 white, tubular, slightly fragrant flowers. Each segment of the black, four-segmented fruits contains a single seed surrounded by fleshy pulp (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Phyllostegia kaalaensis* was federally listed as endangered on October 10, 1996 (61 FR 53089), and was State listed as endangered at the same time. This species was included in recovery plans for Oahu plants (Service 1998a). Critical habitat was designated for *P. kaalaensis* on Oahu on June 17, 2003 (68 FR 35950). *Phyllostegia kaalaensis* was accepted as a species distinct from the more common, closely related *P. glabra* in the 1990s (Wagner et al 1999).

Historic and Current Distribution *Phyllostegia kaalaensis* is endemic to the Waianae Mountains of Oahu, where it has been known only since the 1970s. When the species was listed in 1996, five occurrences totaling less than 50 individuals were known (61 FR 53089). Available survey data indicate that *P. kaalaensis* has been extirpated in the wild since the late 1990s. The causes for its extirpation are unknown. The Waianae Kai population unit, for example, was first discovered in 1993 at about 30 plants, all of which had disappeared by 2004. Currently, there is one existing population unit with only two augmented immature plants located on State land in the Keawapilau to Pahole population unit (Table SB 29) (U.S. Army Garrison 2006c). This population unit is being established at two reintroduction sites using greenhouse-propagated stock, and is far from reaching minimum numerical stabilization criterion (defined as 50 mature, reproducing individuals per population unit). Moreover, these reintroductions have not been very successful, with very low survival rates. Demographic data for this species indicate reproduction in this species is probably primarily through vegetative cloning, as most of the previously known, naturally occurring plants occurred in dense patches far away from any other plants of the species. In addition, cuttings were salvaged from the Keawapilau to Pahole, Palikea Gulch, and Waianae Kai population units and are now being maintained as *ex situ* living collections. The Keawapilau to Pahole population unit and Palikea Gulch population unit are located within the Makua action area and the Schofield Barracks Military Reservation action area, respectively, where they are at zones of very low risk to training-related wildfire. Thus, *P. kaalaensis* is characterized by one reintroduced population unit containing only two augmented immature individuals.

Table SB 29. Range-wide Distribution of *Phyllostegia kaalaensis*.

Population Units	Numbers of Known individuals

	1996 (1)	**1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Kapuna*	--	--	2	0/0‡ [0/20]§	0/0 [0/19]	0/0 [0/2]
Keawapilau*	--	--	2			
Pahole*	--	--	10-15			
Ekahanui	--	3	0	0	0	0
Makaha*	0	0	0	0	0	0
Manuwai*	0	0	0	0	0	0
Palikea Gulch	--	1	10	0	0	0
Waianae Kai	--	30	8	0	0	0
Total Individuals	**<50**	**40**	**32-37**	**20** (0/0)† [0/20]	**19** (0/0) [0/19]	**2** (0/0) [0/2]

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (61 FR 53089)
(2) Recovery Plan (Service 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum (U.S. Army Garrison 2005a)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Phyllostegia kaalaensis* typically was found in mesic to dry-mesic areas in gulch bottoms and upper gulch slopes at elevations of 490 to 760 m (1,610 to 2,500 ft). It occurred most commonly in forests dominated by the native trees *Diospyros sandwicensis* and/or *Sapindus oahuensis*, or in forests containing a mix of several tree species, under forest canopy and in sunny openings. Flowering and fruiting occur from January to June. The flowers are presumably pollinated by moths, and the fleshy black fruits are characteristic of seed dispersal by fruit-eating birds (Makua Implementation Team 2003). The branches of *Phyllostegia kaalaensis* often touch ground and take root to produce a separate plant, and reproduction in this species may be primarily through vegetative means. The longevity of *Phyllostegia kaalaensis* individuals is unknown but is probably less than 10 years as with other perennial herbaceous plants; however, vegetative clones have the potential to live indefinitely (Makua Implementation Team 2003). Other demographic information for *Phyllostegia kaalaensis* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal in the wild, and specific environmental requirements.

Threats *Phyllostegia kaalaensis* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. Outplants of *P. kaalaensis* in rocky gulch slopes and bottoms are vulnerable to trampling damage because of its extensive underground rhizome growth.

Occurrences of *Phyllostegia kaalaensis* are also particularly vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770, 68 FR 35950, Service 1998a). Because the plants known in 2003 represent a small number of genetically unique clones, inbreeding depression could potentially occur in *P. kaalaensis* populations. Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *P. kaalaensis* in the wild already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *P. kaalaensis* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

<u>Conservation Needs of the Species</u> Conservation actions that should be implemented for the recovery of *Phyllostegia kaalaensis* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain stability for short-lived perennials. The Keawapilau to Pahole population unit is only partially fenced. This population unit needs augmentation and reintroduction, and reintroductions are needed in the Makaha and Manuwai population units that represent all available genetic stock. Research is needed to test a variety of outplanting techniques and site characteristics. If indications of inbreeding depression are observed, controlled experiments should be conducted by mixing different stocks. Extirpated sites also should be monitored periodically for regeneration. Reintroductions for establishment of this and other population units cannot proceed until fences are built for the Upper Kapuna, Manuwai, and Makaha Management Units. The Makaha Management Unit and part of the Upper Kapuna Management Unit are scheduled for fence construction in 2007 or shortly thereafter.

<u>Ongoing Conservation Actions</u> Since listing, the Makua Implementation Team (2003) has developed stabilization protocols for *Phyllostegia kaalaensis*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Only the Pahole portion of the Keawapilau to Pahole population unit is fenced and partially weeded. *Phyllostegia kaalaensis* can be successfully propagated from cuttings. However, this species has the lowest survival rate for any taxon the Army has outplanted so far (maximum 32 percent) (U.S. Army Garrison 2005b). In 2005, *P. kaalaensis* was represented in *ex situ* collections that included 723 apical and lateral vegetative buds in micropropagation (Harold L. Lyon Arboretum), 104 cuttings in a nursery (Harold L. Lyon Arboretum), and three seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b). Very little seed was ever collected and no seed has ever been tested for storage and most storage is with cuttings from now-extinct occurrences in the Keawapilau to Pahole, Palikea Gulch, and Wiaiane Kai population units (U.S. Army Garrison 2005b).

Critical Habitat Description A total of 843 ha (2,082 ac) of critical habitat in six separate units was designated for *Phyllostegia kaalaensis* on Oahu. Critical habitat was designated on State lands (Mokuleia and Waianae Kai Forest Reserves, and Pahole and Mt. Kaala Natural Area Reserves) and private land (Honouliuli Preserve). Three units each provide habitat for one population, two units combined provide habitat for one population, and one unit provides habitat for six populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *P. kaalaensis* (68 FR 35950).

The primary constituent elements of critical habitat include gulch slopes or bottoms or almost vertical rock faces in mesic forest or *Sapindus oahuensis* forest at elevations between 248 and 878 m (813 and 2,880 ft). In addition, all units contain one or more of the following associated native plant species: *Antidesma platyphyllum*, *Claoxylon sandwicense*, *Diplazium sandwichianum*, *Freycinetia arborea*, *Hibiscus* sp., *Myrsine lanaiensis*, *M. lessertiana*, *Neraudia melastomifolia, Pipturus albida*, *Pouteria sandwicensis*, *Psychotria hathewayi*, *Streblus pendulinus*, or *Urera glabra*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Only two immature individuals of *Phyllostegia kaalaensis*, representing all of the known individuals of this species, are located within the action area, on State land in the Keawapilau to Pahole population unit (see Table SB 29). Plants in the Pahole portion of the population unit were last observed in 2000, in a fenced area protected from pigs. These last plants may have been extirpated due to drought-induced invasion of non-native invasive weeds. Survivorship rates in the Pahole and Keawapilau portions of the population unit have been very low. Immature individuals were outplanted in a wide variety of sites, from deeply shaded to sunny exposed areas; so far, the healthiest plants are those in sunny openings. *Phyllostegia kaalaensis* plants in the action area are located in areas at risk of training-related wildfire. Both remaining individuals occur in the very low fire risk zone. Thus, *P. kaalaensis* in the action area is characterized by one population unit of two reintroduced immature plants that comprise 100 percent of all remaining individuals, and are located in a zone at very low risk of training-related wildfire.

Status of Critical Habitat in the Action Area The action area contains a total of 107 ha (263 ac), or 13 percent of the total critical habitat for *Phyllostegia kaalaensis*. Designated critical habitat is located within two units in the northeastern portion of the action area. These critical habitat areas are portions of two larger critical habitat units that combined form 646 ha (1,596 ac) and extend outside the action area boundary to provide habitat for 6 populations of *P. kaalaensis*. Critical habitat for this species in the action area occurs in areas at risk of training-related wildfire, with 8.1 ha (19.9 ac) located in the low fire risk zone and 98.4 ha (243.1 ac) in the very low fire risk zone. It is estimated that more than half of the critical habitat occurs in areas with predominantly non-native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Phyllostegia kaalaensis* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. About 13 percent of critical habitat for this species is located in areas at low and very low risks of training-related wildfire. Thus, because there are only two known remaining individuals within the action area, *Phyllostegia kaalaensis* in the action area area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Phyllostegia kaalaensis* because no population units meeting numerical criteria for stabilization exist outside the action area. Three population units have been identified for stabilization of *P. kaalaensis*: Keawapilau to Pahole in the action area, and Makaha and Manuwai outside the action area. The Kapuna and Keawapilau portions of the Keawapilau to Pahole population unit are not fenced. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Keawapilau to Pahole population unit, which contains all *in situ* individuals of *Phyllostegia kaalaensis*, is being managed as specified in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located in the action area within the fenced Pahole Management Unit. A total of about 237.7 ha (587.0 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Ekahanui, Kahanahaiki, Kaimuhole, Makaha, Manuwai, Pahole, Upper Kapuna, West Makaleha). About 98.0 ha (242.0 ac) of the total critical habitat that is within management units is located inside the action area (Kahanahaiki, Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were about four percent complete, with six plants towards the goals outlined in the Makua Implementation Plan. In addition, there were six plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Plantago princeps* var. *princeps* (Ale, Laukahi kuahiwi)

Species Description *Plantago princeps* is a short-lived woody perennial of the Plantaginaceae (plantain) family. It is a shrub at least 1 m (3.3 ft) tall that is single-stemmed or sparingly branched at the base. The leathery, oblong leaves are up to 20 cm (7.8 in) long and clustered at the branch tips. The stem tips usually bear several erect inflorescences, each of which consists of a single stem of small, densely arranged flowers on the upper portion. The small capsules contain three to four black seeds that are 1.5 to 2.1 mm (0.06 to 0.08 in) long. Seed surfaces are covered by a sticky mucilaginous membrane (Wagner et al 1999; Makua Implementation Team 2003).

There are four varieties of *Plantago princeps*: var. *anomala* (Kauai), var. *laxiflora* (Molokai, Maui, and Hawaii), var. *longibracteata* (Kauai and Koolau Mountains of Oahu), and var. *princeps* (Waianae and Koolau Mountains of Oahu). All are woody shrubs except *P. princeps* var. *longibracteata*, which is herbaceous. In addition to geographic distribution, these varieties are distinguished by the amount of pubescence on stems, leaves, and flowers; size and venation of leaves; and orientation of flowers.

Listing Status *Plantago princeps* was federally listed as endangered on November 10, 1994 (59 FR 56333), and was State listed as endangered at the same time. This species is included in the recovery plan for multi-island plants (Service 1999a). Critical habitat was designated for *P. princeps* on Oahu on June 17, 2003 (68 FR 35950); on Kauai on February 27, 2003 (68 FR 9116); on Molokai on March 18, 2003 (68 FR 12982); and on Maui on May 14, 2003 (68 FR 25934). All varieties are included in the listed taxon.

Historic and Current Distribution *Plantago princeps* is a species endemic to the Hawaiian Islands. Historically, *Plantago princeps* was found on Kauai, Oahu, Molokai, Maui, and Hawaii (where it no longer exists). The two varieties that historically occurred on Oahu are var. *princeps* and var. *longibracteata*. Survey data indicate *P. princeps* var. *princeps*, a woody variety, is currently the only variety extant on Oahu. *Plantago princeps* var. *princeps* has been recorded from three general areas on Oahu, including the leeward Waianae Mountains, windward Waianae Mountains, and southeastern Koolau Mountains (Kalihi, Nuuanu, and Manoa valleys). *Plantago princeps* var. *princeps* was rediscovered in 1987 in the North Branch of North Palawai Gulch; before then, the species had not been seen in the Waianae Mountains since the 1800s. Similarly, the species had not been seen in the Koolau Mountains for over 50 years until this variety was rediscovered in 2001 at Waiawa, near the Koolau summit ridge. Currently, most of the known *P. princeps* var. *princeps* population units are scattered throughout the leeward and windward sides of the Waianae Mountains. *Plantago princeps* var. *longibracteata*, the herbaceous variety, historically was known from Kauai and the Koolau Mountains of Oahu. This variety still occurs on Kauai but is now extirpated from Oahu.

Since listing, available survey data indicate the State-wide total number of individuals of *Plantago princeps* (including all four varieties) appears to be stable or possibly increasing, though this increase could be due to more diligent survey efforts (Table SB 30). When the species was listed in 1994, all four varieties totaled 300 to 1,200 individuals State-wide (59 FR 56333); currently, there are 354 individuals on Oahu and an unknown number State-wide (Hawaii Biodiversity and Mapping Program 2005). When the species was listed, there were five occurrences totaling about 20 individuals on Oahu. *Plantago princeps* var. *princeps* is currently known from nine population units totaling 354 individuals on Oahu, located on Federal, State, and private lands (68 FR 35950). Because all currently known population units of this species were discovered relatively recently, trends in abundance and distribution are difficult to determine. A rapid decline from 20 to 5 individuals of *P. princeps* var. *princeps* was documented in the North Palawai population unit over 1987 to 2003, attributed to competition with daisy fleabane (*Erigeron karvinskianus*), a highly invasive non-native plant (Makua Implementation Team 2003). Trends in abundance and distribution on Oahu indicate that *P. princeps* var. *princeps* has increased since 2003, from eight population units totaling up to 253 individuals to nine population units totaling 354 individuals. None of the currently known population units contains more than fifty mature, reproducing individuals (the minimum number required for stabilized populations as defined in the Makua Implementation Plan) (Makua Implementation Team 2003; U.S. Army Garrison 2005b). *Plantago princeps* var. *princeps* is present in both the Makua and Schofield Barracks action areas in the Ohikilolo, Pahole, and North Mokiakea population units, in areas at risk from training-related wildfire (Service 2003a).

Demographic data for this species indicates most of the population units of wild *Plantago princeps* var. *princeps* are recruiting successfully (U.S. Army Garrison 2005b). Three Oahu population units have increased in numbers since 2003, three have decreased, and three have remained more or less the same. However, increases in two of the population units are due to refinement of age classes and discovery of additional individuals as a result of more consistent monitoring efforts, not a significant change in numbers or distribution (U.S. Army Garrison 2005b). Thus, *P. princeps* var. *princeps* is characterized by nine population units, each of which contain fewer than fifty mature, reproducing individuals and an overall trend in abundance on Oahu that appears to be increasing but is due in part to increased monitoring efforts.

Table SB 30. Range-wide Distribution of *Plantago princeps* var. *princeps.*

Population Units	**Number of Known Individuals**					
	1994 (1)	**1999** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Ohikilolo*	--	--	14	22/0	22/12	12/14
Pahole	--	--	12	2/2	3/13	2/14
Ekahanui*	--	--	16/7‡	33/50	34/88	34/86
Halona	--	--	50-100	50-100	10/28	10/28
Konahuanui/ Kaneohe (Koolau)*	--	--	--	40/5	40/5	40/5
North Mohiakea/Puu Kalena (SBWR)	--	--	70	20/3	15/5	10/13
North Palawai (north branch)	--	--	7	2/2	1/1	--
North Palawai (south branch)	--	--	25	0	--	1/1
Nuuanu	--	--	--	1/0	1/0	1/0
Waiawa (Koolau)*	--	--	40/2	16/17	16/67	16/67
Total Population Units Oahu (2 varieties)	5	7	8	9	10	9
Total Individuals Oahu (2 varieties)	**20+**	**150-250**	**253-303** (234-284/19)†	**265-315** (186-236/79)	**361** (142/219)	**354** (126/228)
Total Population Units State-wide (all 4 varieties)	18	29	27	--	20	490-1962(7)
Total Individuals State-wide (all 4 varieties)	**300-1200**	**640-1750**	**795-973**	--	**844-2316**	**844-2316**

Shaded population units are inside the action area.

* Stabilization population units
SBMR = Schofield Barracks Military Reservation, West Range.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (59 FR 56333)
(2) Recovery plan (Service 1999a)
(3) Makua Implementation Plan (Makua Implementation Team 2003) and critical habitat rules (68 FR 9116; 68 FR 12982; 68 FR 25934; 68 FR 35950)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b); Hawaii Biodiversity and Mapping Program 2005; M. Bruegmann, USFWS, pers. comm. (2006)
(6) 2006 status update (U.S. Army Garrison 2006c)
(7) S. Ching, pers. comm. (2007)

Ecology *Plantago princeps* var. *princeps* occurs in two different habitat types, at elevations of 480 to 1,100 m (1,580 to 3,600 ft) (Service 1999a). In the Waianae Mountains, this variety is found on cliff faces, ledges, and bases, in mesic vegetation consisting predominantly of native grasses, sedges, herbs, and shrubs. Historical occurrences in the southeastern Koolau Mountains also were found in mesic cliff habitats. In contrast, the Waiawa population unit occurs on a streamside embankment in wet, rainforest habitat close to the Koolau summit ridge, an area with the highest precipitation on Oahu (Service 2003a). *Plantago princeps* var. *princeps* appears to produce flowers and fruits throughout the year (Wagner et al 1999), with increased fruiting in the spring (U.S. Army Garrison 2005b). The sticky seeds may have once been dispersed by now-extinct species of flightless birds (Carlquist 1980; Makua Implementation Team 2003). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *P. princeps* var. *princeps* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Plantago princeps* var. *princeps* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Because this species prefers cliff habitat, ungulate and weed threats are relatively low (U.S. Army Garrison 2005b). Rat predation on fleshy stems and leaves is a problem in the North Palawai and Ekahanui population units (in Honouliuli Preserve), and may have caused the near disappearance of the North Palawai population units (U.S. Army Garrison 2005b). Fire is a threat to population units in Army action areas (Ohikilolo, Pahole, and North Mohiakea) and to areas vulnerable to non-military related fire. For example, fire burned native vegetation in parts of the Ekahanui Management Unit and near the Halona population unit during summer 2005 (U.S. Army Garrison 2005b). In addition, occurrences of *P. princeps* var. *princeps* are vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (59 FR 56333; 68 FR 35950; Service 1999a). Thus, *P. princeps* var. *princeps* has a high background risk of species extinction, and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species   Conservation actions that should be implemented for the recovery of *Plantago princeps* var. *princeps* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). The Army has noted that a re-evaluation of stabilization population units may be needed to account for the recently discovered population unit on the Kaneohe side of Puu Konahuanui (currently the largest population unit at 45 total individuals) (U.S. Army Garrison 2005b). A pig-proof fence is needed for the Ekahanui population unit and is planned for 2007. A fence is also needed for the Waiawa population unit and is planned as part of the Army's Oahu Implementation Plan (U.S. Army Garrison 2005b).

Ongoing Conservation Actions   The Makua Implementation Team (2003) has developed stabilization protocols for *Plantago princeps* var. *princeps*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Ohikilolo, Pahole, and Ehakanui population units are fenced and protected by cliffs and steep terrain. In addition, about 271 individuals (77 percent of all remaining individuals on Oahu) of this species occur in five management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Palikea and Waiawa, which are not fenced; and Ekahanui, Ohikilolo, and Pahole, which are fenced. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit *P. princeps* in the Ekahanui and Palawai population units within the preserve. This species is also included in the Army's stabilization plan for species impacted by military training at other areas on Oahu associated with Schofield Barracks Military Reservation (Service 2003a).

Seed collection from this taxon is difficult because it inhabits inaccessible cliffs. Plants fruit year-round, with peak production in the spring, and germination rate of fresh seed is about 60 percent. Cuttings can be successfully propagated, but the plants do not survive well in the greenhouse (U.S. Army Garrison 2005b). *Plantago princeps* is represented in *ex situ* collections, including four cuttings in a nursery (Army Environmental Division, Oahu), 81 plants in a nursery (Haleakala National Park), 39 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), and 5,900 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description   A total of 2,632 ha (6,504 ac) in 12 separate units on four islands was designated as critical habitat for *Plantago princeps*, including 1,418 ha (3,504 ac) in five units on Oahu (68 FR 35950). Critical habitat on Oahu was designated on Federal (Oahu Forest National Wildlife Refuge), State (Ewa, Mokuleia, and Waiahole Forest Reserves and Pahole Natural Area Reserve), and private lands (including Honouliuli Preserve). The 12 critical habitat units State-wide provide habitat to support nine populations, and the five critical habitat units on Oahu provide habitat for three populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *P. princeps* (68 FR 35950).

On Oahu, the primary constituent elements for three critical habitat units in the Waianae Mountains include slopes or ledges in *Metrosideros polymorpha* lowland mesic forests or shrublands at elevations between 110 and 1,064 m (361 and 3,490 ft). In addition, all units contain one or more of the following associated native plant species: *Artemisia australis*, *Bidens* sp., *Chamaesyce* sp., *Dubautia plantaginea*, *Eragrostis* sp., *Lysimachia* sp., *Pilea peploides*, or *Viola* sp. The primary constituent elements for the two critical habitat units in the Koolau Mountains include sides of waterfalls or wet rock faces at elevations between 211 and 885 m (692 and 2,903 ft) that contain one or more of the following associated native plant species: *Bidens* sp., *Coprosma granadensis*, *Eugenia* sp., *Lobelia gaudichaudii*, *Metrosideros rugosa*, or *Scaevola glabra*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 42 individuals, or 12 percent of all known individuals of Plantago princeps var. princeps on Oahu, are located within the action area in the Ohikilolo and Pahole population units (see table above) (U.S. Army Garrison 2005b). These action area individuals represent 12 percent of the total State-wide population. None of the population units exceeds 50 mature reproducing individuals (the minimum number required for a stabilized population). Overall, the total known number of individuals of this taxon in the action area has increased from 26 in 2003 to 42 individuals in 2006, but most of that increase is due to discovery of additional plants in the Ohikilolo population unit (U.S. Army Garrison 2005b). Currently, about 67 percent of the action area individuals are immature plants, compared to less than eight percent immature individuals in 2004. The Ohikilolo and Pahole population units within the action area are located in fire risk zones; however, all known individuals occur in the low fire risk zone. These individuals at risk of fire in the action area represent about 12 percent of the taxon's total known number of individuals on Oahu and about one percent of the species' State-wide total. Thus, *P. princeps* var. *princeps* in the action area is characterized by two population units which do not meet the numerical criteria for a stabilization population unit and represent about 12 percent of the taxon's total number of individuals on Oahu. The total number of known individuals has increased primarily due to new discoveries from refined monitoring efforts.

Status of the Critical Habitat in the Action Area The action area contains a total of 62 ha (153 ac), or two percent, of the total State-wide critical habitat for *Plantago princeps*. Critical habitat is located on State land in the northeastern portion of the action area, in two critical habitat units. These units total 15 ha (37 ac) and 53 ha (130 ac), respectively, and together extend beyond the action area to provide habitat to support one population of 300 mature, reproducing individuals. The entire acreage for both of these critical habitat units occurs in the low fire risk zones of the action area. State-wide, slightly more than one percent of critical habitat for this species on Oahu, Kauai, Maui, and Hawaii is located in an area at risk from training-related wildfire, with none located in the high fire risk zone. It is estimated that almost all critical habitat is in areas of greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area   The primary threats to *Plantago princeps* var. *princeps* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Although only 12 percent or less of all known individuals of this taxon on Oahu occurs within the action area, *P. princeps* var. *princeps* in the action area has a high background risk of species extinction and requires ongoing stabilization management to ensure its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area   The Makua Implementation Plan Addendum (U.S. Army Garrsion 2005a) includes *Plantago princeps* var. *princeps* because the no population units meeting minimum numerical criteria for a stabilization population exist outside the action area. Stabilization goals to improve the status of *P. princeps* var. *princeps* include management to attain three population units, each with a minimum of 300 mature, reproducing individuals. Three population units have been identified for stabilization of *P. princeps var. princeps*: Ohikilolo, Ekahanui, and Waiawa. Augmentation of the Ohikilolo and Pahole population units is needed as soon as propagation and outplanting techiques are refined; the Army has not outplanted this taxon yet because of difficult access at field sites (U.S. Army Garrison 2005b). Post-fire revegetation plans and site-specific fuels modification are needed for the Ohikilolo, Pahole, Upper Kapuna, and West Makaleha Management Units, which either contain individuals or portions of critical habitat. The 42 individuals of this species occurring in the action area are in fenced management units and this species will thus benefit from ungulate exclusion. There are no plans to fence the small portion of the Upper Kapuna Management Unit that coincides with critical habitat. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area   The Ohikilolo population unit is being managed as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). Within the action area, the Ohikilolo and Pahole Management Units are proposed to be fenced starting in 2007 and completed by 2015 thus controlling ungulates. Weed management will be an ongoing strategy to control invasive species. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, and goats have been virtually eradicated from Makua (U.S. Army Garrison 2005b). Genetic storage goals are nine percent complete, with 41 plants from all nine population units combined meeting the goals outlined in the Makua Implementation Plan, and there are 10 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species – *Pritchardia kaalae* (Loulu)

Species Description   *Pritchardia kaalae* is a long-lived palm of the Arecaceae (palm) family. The tree grows to 5 m (16.4 ft) tall, with a single erect trunk surmounted by a cluster of fan-shaped fronds. The inflorescences are as long as the frond tips and often extend well beyond them, and consist of flowers in one or more clusters. *Pritchardia* species usually, if not always, have perfect flowers (with both male and female reproductive parts), and *P. kaalae* is probably self-compatible. The round, fleshy fruits are about 2 cm (0.8 in) in diameter and much smaller than fruits of other *Pritchardia* species (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Pritchardia kaalae* was federally listed as endangered on October 10, 1996 (61 FR 53089), and was State listed as endangered at the same time. This species is included in the recovery plan for Oahu plants (Service 1998a). Critical habitat has not been designated for this species.

Historic and Current Distribution *Pritchardia kaalae* is a species endemic to the Hawaiian Islands and to the island of Oahu. Trends in distribution indicate that *P. kaalae* historically was found only in the northern Waianae Mountains of Oahu. In contrast to other *Pritchardia* species in Hawaii, no evidence indicates that the distribution of *P. kaalae* has been influenced by the actions of native Hawaiians (Makua Implementation Team 2003). When the species was listed in 1996, there were five occurrences totaling approximately 130 individuals. Since listing, the total number of individuals has increased to about 911 plants (see table below). However, 85 percent of these are immature plants and 15 percent are mature plants; there are only 137 mature trees range-wide (U.S. Army Garrison 2005b). Two of the five currently known population units have exceeded minimum thresholds for a stabilization population (defined as at least 25 mature, reproducing individuals per population unit for long-lived perennials) (Makua Implementation Team 2003; U.S. Army Garrison 2005b). Population units of *P. kaalae* are located on Federal and State lands (U.S. Army Garrison 2005b) (Table SB 31).

Demographic data indicate the number of mature trees has been slowly decreasing as older trees die and few immature plants are available to take their place (Makua Implementation Team 2003). Since consistent monitoring for this species began at Makua about 10 years ago, little or no recruitment has been observed in wild population units due to goat and rat predation and uprooting by pigs (U.S. Army Garrison 2005b). The Ohikilolo population unit is the only one with documented seedlings (410 immature individuals including seedlings). With protection and management, many seedlings are appearing, and rat control should result in significant increases in recruitment rates (Makua Implementation Team 2003). In addition, *Pritchardia kaalae* is easy to grow from seed and outplantings have been extremely successful (U.S. Army Garrison 2005b). Nonetheless, both augmented and naturally occurring seedlings and immature plants grow very slowly and do not become reproductive for decades. Plants in the Ohikilolo population units are located in zones at low risk from training-related wildfire. Thus, *P. kaalae* is characterized by five population units, two of which exceed minimum numeric criteria for stabilization, low numbers of mature trees and an overall abundance that is increasing through augmentation and enhanced survival of seedlings and immature plants associated with habitat management.

Table SB 31. Range-wide Distribution of *Pritchardia kaalae.*

Population Units	Number of Known Individuals					
	1996 (1)	**1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Ohikilolo*	--	--	65/100‡	72/3 [0/308]§	75/221 [0/274]	75/410 [0/284]
Ohikilolo East & West Makaleha*	--	--	--	0 [0/75]	0 [0/32]	0/0 [0/72]
Makaha	--	--	1/0	1/0	4/0	4/0
Makaleha to Manuwai*	--	--	138/3	39/3	50/2	54/3
Waianae Kai	--	--	7/2	7/2	4/5	4/5
Total Individuals	**130**	**130**	**316** (211/105)†	**510** (119/8) [0/383]	**667** (133/228) [0/306]	**911** (137/418) [0/356]

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (61 FR 53089)
(2) Recovery plan (Service 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Pritchardia kaalae* occurs in the mesic zone on moderately steep slopes to very steep cliffs at elevations of 450 to 980 m (1,476 to 3,215 ft) (Wagner et al 1999; Makua Implementation Team 2003). Many *P. kaalae* plants at lower elevations are found in forests dominated by *Diospyros sandwicensis* or *Metrosideros* species; at higher elevations, they are found in the upper, wetter zone of mesic forest dominated by *Metrosideros tremuloides*. The common habitat of *P. kaalae* is steep, open cliffs vegetated with grasses and sedges, shrubs, and small trees (Makua Implementation Team 2003). Recent studies of fossil pollen and charcoal deposits on Oahu indicate that *Pritchardia* constituted a major element of lowland vegetation when Polynesians first settled in Hawaii. Fruit predation by the Polynesian rat brought by early Polynesian settlers appears to have caused a collapse of these *Pritchardia* populations. The *Pritchardia* species of this largely vanished lowland vegetation have not been identified, but *P. kaalae* possibly may have extended from the Waianae Mountains into the lowland populations that were decimated by rats (Makua Implementation Team 2003). Seeds of the related species *P. remota* can survive in the soil for “a significant period of time” (U.S. Army Garrison 2005b). The longevity of *P. kaalae* has not been documented but is presumed to be many decades (Makua Implementation Team 2003). Other demographic information for *P. kaalae* in the wild is unknown, including growth rate, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements.

Threats to the Species *Pritchardia kaalae* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Pritchardia kaalae* is particularly vulnerable to seedling predation by goats and fruit predation by rats (Makua Implementation Team 2003; U.S. Army Garrison 2005b). This species may also be vulnerable to lethal yellowing, a palm disease prevalent in many tropical and subtropical zones worldwide. Hawaiian *Pritchardia* species planted in Florida as ornamentals are extremely susceptible to this fatal, incurable disease. Lethal yellowing is caused by a "mycoplasma-like organism" transmitted by a sap-sucking plant hopper, *Myndus crudus*, which has not yet been found in Hawaii (Murakami 1999). Nonetheless, lethal yellowing disease remains a potential serious threat to *P. kaalae* on Oahu. Thus, *P. kaalae* has a high background risk of species extinction due to low numbers and serious threats from non-native predators and disease, and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Pritchardia kaalae* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Pritchardia kaalae*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Ohikilolo and Makaleha to Manuwai population units have met minimum numerical criteria for a stabilization population, but threats are not fully controlled and genetic storage is not complete. The Ohikilolo East and West Makaleha population unit within the action area is being established by reintroduction. In addition, about 898 individuals (98 percent of all remaining individuals) of this species occur in four management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Manuwai, East Makaleha, and West Makaleha, which are not fenced; and Ohikilolo, which is fenced.

Germination from seed is a reliable propagation technique for *Pritchardia kaalae*, particularly using excised embryos (50 percent germination). Reintroductions in the wild have been successful, but seedlings grow very slowly; survival of two-year-old outplants is about 89 percent (U.S. Army Garrison 2005b). *Pritchardia kaalae* is represented in *ex situ* collections including 172 embryos in micropropagation (Harold L. Lyon Arboretum), 193 mature fruit in storage or awaiting processing at a nursery (Army Environmental Division, Oahu), seven plants in a botanical garden (Waimea Valley Audubon Center), and 12 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Environmental Baseline of the Species

Status of the Species in the Action Area About 841 individuals, or 92 percent of all known individuals of *Pritchardia kaalae*, are located within the action area in the Ohikilolo, and Ohikilolo East and West Makaleha population units (see table above). However, only 75 of these individuals in the action area are mature trees, which represent about 55 percent of the total 137 mature trees that exist range-wide. The Ohikilolo population unit has currently exceeded the minimum numerical criteria for a stabilization population (defined as 25 mature individuals per population unit) and includes both naturally occurring and reintroduced plants. The Ohikilolo East and West Makaleha population unit consists entirely of 72 augmented immature plants that have been outplanted in fenced areas since 2002. Currently, about 91 percent of the action area individuals are immature plants. Overall, action area numbers of *P. kaalae* have increased since 2003, from 165 (including 65 mature trees) to 841 (including 75 mature trees) (U.S. Army Garrison 2005b; Army database 2006). All *P. kaalae* plants in the action area are at risk from training-related wildfire; however, all individuals of this species found in the action area are located in the low or very low fire risk zones. These individuals at risk of fire in the action area represent about 92 percent of the species' total range-wide numbers.

The Ohikilolo population unit is located within the Ohikilolo Management Unit, where vegetation consists of native dry cliff communities, ridgetop mesic native shrubland dominated in some areas by *Dodonaea* and *Metrosideros* species, and areas of *Pritchardia kaalae* lowland mesic forest, a rare natural community (U.S. Army Garrison 2005a). The Ohikilolo East and West Makaleha population unit is located in parts of the Ohikilolo, East Makaleha, and West Makaleha Management Units. Vegetation in the East Makaleha Management Unit consists of dry-mesic to wet native forest and shrubland, and alien-dominated dry-mesic to wet-mesic shrubland and forest (U.S. Army Garrison 2005a). Vegetation in the West Makaleha Management Unit consists primarily of mixed alien-dominated mesic forest and native-dominated forest and shrubland, with areas of Oahu diverse lowland mesic forest, a rare natural community. At lower elevations, vegetation in the West Makaleha Management Unit consists of seasonally dry, alien-dominated forest and shrubland (U.S. Army Garrison 2005a). Two hundred seventy five (30 percent of the individuals range-wide) both mature and immature individuals of *P. kaalae* are within fenced management units in the action and will therefore benefit from ungulate exclosure. Thus, *P. kaalae* in the action area is characterized by one population unit containing 92 percent of all remaining individuals and 55 percent of all mature individuals, which is increasing due to habitat management and augmentation, and another population unit that is being established through reintroduction.

<u>Threats to the Species in the Action Area</u> The primary threats to *Pritchardia kaalae* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Thus, because 92 percent of all known individuals and 55 percent of all mature trees occur within the action area, *P. kaalae* in the action area has a high background risk of species extinction; any additional threats could eliminate the expectation of its long-term persistence.

<u>Conservation Needs of the Species in the Action Area</u> The Makua Implementation Plan Addendum (U.S. Army Garrsion 2005a) includes *Pritchardia kaalae* because there are only two population units exceeding minimum numerical criteria for a stabilization population, including only one outside the action area. Three population units are identified for stabilization of *P. kaalae*: Ohikilolo and Ohikilolo East and West Makaleha in the action area, and Makaleha to Manuwai outside the action area. The Ohikilolo population unit within the action area has exceeded minimum numerical criteria for a stabilization population, although threats are not fully controlled and genetic storage is not complete. The Ohikilolo East and West Makaleha

population unit is being established by reintroduction and will be managed for stabilization, but will not contain mature trees for many years. The East Makaleha and West Makaleha Management Units are not fenced, and ungulates and weeds are minimally controlled; fence construction is planned for 2008 and 2009, respectively (U.S. Army Garrison 2005b). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species in the Action Area</u> The Ohikilolo, and Ohikilolo East and West Makaleha, population units within the action area are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). In addition, this species occurs in the East Makaleha, Ohikilolo, and West Makaleha Management Units within the action area. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, goats have been virtually eradicated from Makua, and weeds and rats are controlled in some *P. kaalae* occurrences (U.S. Army Garrison 2005b). The other management units are not fenced. Genetic storage goals are about 13 percent complete, with 27 plants from all four population units combined meeting the goals outlined in the Makua Implementation Plan, and there are also 30 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Sanicula mariversa* (No Common Name)

<u>Species Description</u> *Sanicula mariversa* is a perennial herbaceous plant in the Apiaceae (parsley family). Basal leaves arise from a thick underground storage root, and are up to 23-cm (9 in) wide with three to five lobes. The yellow flowers are borne in masses on stems up to 0.7 m (2.3 ft) tall. Some of the flowers are perfect (with both male and female reproductive parts) and others have only staminoid (male) parts. The egg-shaped fruits are 4 to 6 mm (about 0.2 in) long and covered with hooked bristles (Wagner et al 1999; Makua Implementation Team 2003).

<u>Listing Status</u> *Sanicula mariversa* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for this species was designated on June 17, 2003 (68 FR 35950).

<u>Historic and Current Distribution</u> *Sanicula* is a genus endemic to the Hawaiian Islands. Historic data indicate *Sanicula mariversa* occurred in the central Waianae Mountains of Oahu (68 FR 35950). This species was first discovered in the 1970s, on Ohikilolo Ridge, and nothing is known of its past distribution and abundance (Makua Implementation Team 2003). When the species was listed, only two occurrences totaling less than 200 individuals were known. Currently, *S. mariversa* occurs in four population units totaling approximately 224 individuals, none of which is stable (Table SB 32). These population units are found on Federal, State, and city/county lands (68 FR 35950).

Currently demographic data is insufficient to detect trends in *Sanicula mariversa*. Since listing, consistent surveys have been conducted for only two locations. These surveys have shown that annual counts do not necessarily reflect numerical individual trends or the number of mature and immature individuals persisting. *Sanicula mariversa* is a perennial herb that is dormant during the summer. In addition, individual plants do not emerge each year and take many years to mature making detection in the field challenging. Mature plants flower inconsistently and appear to die after flowering once. Environmental conditions, such as large seed production years or favorable germination conditions may influence age at maturity and the length of dormancy periods. All these characteristics result in unpredictable population fluctuations from year to year (U.S. Army Garrison 2005b). Plants in the Keaau and Ohikilolo population units are located in low and very low risk zones for training-related wildfire. Thus, due to low numbers, lack of population units meeting stabilization numeric criteria, and insufficient knowledge of ecological influences on population dynamics, demographic data for *S. mariversa* are insufficient to determine whether the species is sustaining its numbers or declining.

Table SB 32. Range-wide distribution of *Sanicula mariversa*.

Population Units	Numbers of known individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Keaau*	--	--	16/125‡	7/100	14/69	14/114
Ohikilolo*	--	--	34/109	1/62 [0/19]§	0/51	0/52
Kamaileunu*	--	--	26	13/22	3/16	4/36
Puu Kawiwi	--	--	2	0/32	0/36	0/4
Total Individuals	**< 200**	**75**	**312** (78/234)†	**256** (21/216) [0/19]	**189** (17/172)	**224** (18/206)

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduction]

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Sanicula mariversa* occurs on dry, well-drained slopes at elevations of about 750 m (2,461 ft), usually on north-facing slopes just below the ridgeline or on exposed ridge crests. Most of the known plants grow in deep soil, although two plants were found at Puu Kawiwi in the cracks of a nearly vertical rock face (Makua Implementation Team 2003). Leaves and stems die back to the storage root usually in May, and the plants are dormant during the dry summer months until new growth emerges usually in October or November. Flowering occurs from February through May, with fruits maturing a few months later. The massed inflorescences suggest pollination by insects, and bristles on the fruit suggest dispersal by birds. Because *S. mariversa* is an herbaceous species, its longevity probably is similar to that of other small plants that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003).

Other demographic information for *S. mariversa* in the wild is unknown, including longevity, dormancy cycles, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Sanicula mariversa* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Sanicula mariversa* also is threatened by trampling by hunters and hikers on Keaau Ridge, and potentially by fence maintenance activities on Ohikilolo Ridge (Makua Implementation Team 2003). Population units of *S. mariversa* are especially vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a; Service 1998a). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. mariversa* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. mariversa* has a very high background risk of species extinction and additional threats could eliminate expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Sanicula mariversa* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). The numerical criterion for stabilization of short-lived perennials is generally defined as three population units each consisting of 50 mature, reproducing individuals. Owing to infrequent, inconsistent flowering and significant population fluctuations from year to year, this standard was increased for *S. mariversa* to 100 mature, reproducing individuals per population unit. Other particular needs for the conservation of *S. mariversa* include research on seasonal life cycle, dormancy, and seed bank influences, and development of an effective monitoring program to determine whether stabilization criteria should be revised. For example, a five-year average of plants at various stages of maturation may be a more suitable goal for this species than annual counts of observed individuals. In addition, refinement of genetic storage goals require better data on seed dormancy, and propagation techniques must be developed (U.S. Army Garrison 2005b).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Sanicula mariversa*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, individuals of this species occur in three management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Kamaileunu, and Keaau and Makaha, which are not fenced; and Ohikilolo, which is fenced.

Germination trials with fresh *Sanicula mariversa* seed have been unsuccessful, and research is needed to determine dormancy constraints and appropriate propagation and outplanting techniques. In the wild, plants reintroduced in the Ohikilolo population unit have not been seen since 2003, and seed-sowing trials in 1999 resulted in only one germinated plant (U.S. Army Garrison 2005b). In 2005, *ex situ* collections for this species included 11 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) and 11,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Critical Habitat Description A total of 93 ha (230 ac) of critical habitat in six separate units was designated for *Sanicula mariversa* on State lands (Makua, Keaau, and Waianae Kai Forest Reserves and Mt. Kaala Natural Area Reserve) and on private lands (Honouliuli Preserve) on Oahu. One unit provides habitat for two populations and five units together provide habitat for four populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. mariversa* (68 FR 35950).

The primary constituent elements of critical habitat include dry, well-drained, slopes or rock faces in mesic shrublands or open grassy areas at elevations between 475 and 1,025 m (1,558 and 3,362 ft). In addition, all units contain one or more of the following associated native plant species: *Bidens torta*, *Carex meyenii*, *Doryopteris* sp., *Eragrostis* sp., *Metrosideros polymorpha*, or *Metrosideros tremuloides*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat See introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Habitat degradation by goats and trampling by humans on or near trails are particular threats in some *S. mariversa* critical habitat units (68 FR 35950).

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area About 80 percent of all known individuals of *Sanicula mariversa* are located within the action area, in the Ohikilolo and Keaau population units (see Table SB 32). These population units have been monitored since 1995 and 1999, respectively. Neither population unit is currently meeting stabilization numerical criteria (defined as 100 mature individuals). The number of individuals in both population units varies significantly from year to year, ranging from 12 individuals in 1998 to 138 in 2002 in Ohikilolo, and from 11 in 2001 to 107 in 2004 in Keaau. In addition, 19 immature plants were reintroduced to the Ohikilolo population unit in 2001 but have since disappeared (U.S. Army Garrison 2005b). The Army does not plan any future reintroductions or augmentations of *S. mariversa* until more is known about its dormancy cycle. All individuals in the Ohikilolo and Keaau population units are at low and very low risk of training-related wildfire. About 52 individuals occur in the low fire risk zone and 128 individuals in the very low fire risk zone. These population units are located within an extremely dry part of the action area that is buffered somewhat from fire by a strip of thick forest and by sparsely vegetated cliffs (U.S. Army Garrison 2005a). The Ohikilolo population unit is located within the Ohikilolo Management Unit on Makua, which occurs along the steep wall of Makua valley. The Keaau population unit is located within the Keaau and Makaha Management Unit on the saddle ridge between the Keaau and Makaha valleys. Thus, the species is characterized by low numbers of individuals, lack of population units meeting minimum numerical criteria for stabilization, location of 80 percent of the individuals within fire risk zones.

Status of the Critical Habitat in the Action Area A total of 10.0 ha (24.8 ac), or 11 percent, of the total critical habitat for *Sanicula mariversa* is found within two critical habitat units in the action area. These two critical habitat units are located on State land in the south-central part of the action area, and together provide potential habitat to support one population of 300 mature, reproducing individuals. Critical habitat for this species in the action area is located in an area at risk of training-related wildfire, with 0.3 ha (0.8 ac) in the low fire risk zone and 9.7 ha (24.0 ac) in the very low fire risk zone. It is estimated that slightly more than half of the critical habitat within the action area is found in an area with less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Sanicula mariversa* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Sanicula mariversa* in the action area is especially vulnerable to wildfire from military training activities. Feral goats have been substantially reduced in the Ohikilolo population unit, but not in the Keaau population unit. In addition to browsing and trampling, goat activity also has resulted in substantial erosion in parts of the Keaau population unit. About 11 percent of the total critical habitat designated for this species is located in the low and very low fire risk zones. Thus, because about 80 percent of all known individuals occur within the action area in zones of low to very low fire risk, *S. mariversa* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Sanicula mariversa* because more than 50 percent of all known individuals occur within the action area, and no population units meeting minimum numerical criteria for stabilization exist outside the action area. Three population units have been identified for stabilization of *S. mariversa*, only one of which is located outside of the action area: Keaau-and-Ohikilolo within the action area and Kamaileunu outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Management designations may need to be revised to ensure that two population units are stabilized outside the action area. In addition, post-fire revegetation plans and site-specific fuel modification are needed where this species is located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. The critical habitat adjacent to the Ohikilolo Management Unit will not be fenced, but it is located in very steep terrain that limits ungulate and human access (Service 2004a). The Keaau and Makaha Management Unit will be fenced in 2009, and is in need of goat and invasive weed control; there are no plans to fence the Kamaileunu Management Unit. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area Two population units containing 80 percent of the total remaining individuals are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). In addition, this species occurs in two management units in the action area, Ohikilolo, which is fenced, and Keaau-and-Makaha, which is not fenced. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, goats have been virtually eradicated from Makua, and invasive weeds are controlled around *S. mariversa* sites. A total of about 19.6 ha (48.4 ac) of critical habitat for this species is located within management units both within and outside of the action area (Ekahanui, Kamaileunu, Keaau and Makaha, Manuwai, Ohikilolo). About 2.4 ha (6.0 ac) of the total critical habitat that is within management units is located inside the action area (Keaau and Makaha, Ohikilolo). In 2005, genetic storage goals were 42 percent complete, with 84 plants from all four population units combined towards meeting the goals of the Makua Implementation Plan; there were no plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Schiedea hookeri* (No Common Name)

Species Description *Schiedea hookeri* is a relatively long-lived perennial of the Caryophyllaceae (pink) family. It is a sprawling or clumped sub-shrub (stems woody at the base) with stems 0.3 to 0.5 m (1 to 1.6 ft) long that curve slightly upward or lie close to the ground in matted clumps. The narrow, oppositely arranged leaves are 3 to 8 cm (1.2 to 3.2 in) long and 0.4 to 1.5-cm (0.2 to 0.6 in) wide. The small, perfect flowers (with both male and female reproductive parts) have no petals and are borne in open, branched clusters that are hairy and somewhat sticky. The fruit is a capsule about 3 mm (0.1 in) long (Wagner et al 1999).

Listing Status *Schiedea hookeri* was federally listed as endangered on October 10, 1996 (61 FR 53108), and was State listed as endangered at the same time. A recovery plan for multi-island plants included this species (Service 1999a), and critical habitat was designated on June 17, 2003 (68 FR 35950). The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Historic and Current Distribution *Schiedea* is a genus endemic to the Hawaiian Islands. Trends in distribution indicate range restriction in *Schiedea hookeri*, which historically occurred in the Waianae Mountains of Oahu and perhaps occurred on Maui (although the single fragmentary collection from East Maui may represent another species) (61 FR 53108). Currently, this species occurs only in the Waianae Mountains. When the species was listed in 1996, 11 occurrences totaling 220 to 330 individuals were known. Currently, 18 occurrences totaling about 420 individuals are known on Federal, State, city/county, and private lands (Table SB 33) (68 FR 35950). Current numbers include 128 individuals within the Makua action area and 5 individuals within the Schofield Barracks Military Reservation action area (Service 2003a; U.S. Army Garrison 2006c). Trends in numbers and distribution are difficult to discern, however, owing to inconsistent identification of occurrences and monitoring efforts. No range-wide surveys have been conducted for this species. According to the most recent information available, four of the 18 population units have reached stabilization population minimum numerical criteria (defined as at least 50 mature, reproducing individuals); three of these stabilization populations are located outside the action area (Service 1999a; U.S. Army Garrison 2006c). No recent information is available on trends in reproduction in the wild, and there is no evidence of reproduction from seed under field conditions (Service 1999a). Plants in the Kahanahaiki, Kaluakauila, Keaau, Ohikilolo, and North Mohiakea occurrences are located in zones at risk from training-related wildfire. Thus, *S. hookeri* is characterized by apparently increasing trends in numbers and reaching minimal numeric criteria for a stabilization population in four of the 18 existing occurrences.

Table SB 33. Range-wide Distsribution of *Schiedea hookeri*.

Population Units	**Number of Known Individuals**			
	1996 (1)	**2003** (2)	**2005** (3)	**2006** (4)
Kahanahaiki	--	--	20	20
Kaluakauila	--	6-10	52	52/0/40‡
Keaau	--	--	12	12
Ohikilolo	--	--	4	4
Lower Kaala Natural Area Reserve	--	--	37	50
Kalena-Kaala Ridge	--	--	--	--
Kaluaa to Ekahanui	--	60	110	2
Kamaileunu Ridge	--	11	--	--
Kolekole/Puu Hapapa	--	10	--	--
Makaha/Makaha-Waianae Kai Ridge	--	40	--	--
Makua/Makaha Ridge	--	4	5	17
North Mohiakea (SBWR)	--	5	--	--
North Waieli	--	--	3	3
Palikea Gulch	--	10	--	20
Puu Kaua	--	55	50	50
Waianae Kai/ Waianae Kai Ridge	--	63	94-144	150
Total Individuals	**220-330**	**333-383**	**387-437**	**420**^
Other Locations				82

Shaded occurrences are inside the action area; numbers include total individuals.
SBWR = Schofield Barracks West Range.
‡Total mature/immature/seedling individuals
^Totals from Army database

(1) Listing rule (61 FR 53108), recovery plan (Service 1999a)
(2) Critical habitat rule (68 FR 35950), Oahu Biological Opinion (Service 2003a)
(3) Army re-initiation request (U.S. Army Garrison 2005c)
(4) Army database (U.S. Army Garrison 2006d)

Ecology *Schiedea hookeri* occurs in the understory of diverse mesic or dry lowland forests typically dominated by *Metrosideros polymorpha* or *Diospyros* species, at elevations ranging between 350 and 900 m (1,148 and 2,953 ft) (61 FR 53108; 68 FR 35950; Wagner et al 1999). It usually grows on slopes, cliffs and cliff bases, rock walls, and ledges. *Schiedea hookeri* is an outcrossing species probably pollinated by insects. Mature fruits have been observed in June and August, but seed dispersal mechanisms are unknown. This species varies considerably throughout its range in potential for vegetative (clonal) growth and spread. Upright plants at one site, for example, show little clonal potential, whereas decumbent plants at another site exhibit clonal growth by nodal rooting (68 FR 35950; Service 1999a). Plant longevity is probably similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials). Other demographic information for *S. hookeri* in the wild is unknown, including phenology, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Schiedea hookeri* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Schiedea hookeri* is particularly vulnerable to predation by non-native slugs and snails (61 FR 53108). Seedlings from other *Schiedea* species that occur in mesic or wet sites are apparently consumed by these alien invertebrates. One study noted, for example, that seedling mortality for the related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). *Schiedea* species that occur in dry areas, however, produce abundant seedlings following winter rains, perhaps because drier sites have fewer non-native invertebrate herbivores (Service 1999a). *Schiedea hookeri* also may suffer from a lack of pollinators (Service 1999a). Wildfire ignited by military training activities is a threat to this species in the Makua and Schofield Barracks action areas.

Occurrences of *Schiedea hookeri* are probably not as vulnerable as other endangered *Schiedea* species to extirpation from naturally occurring events and/or reduced reproductive vigor due to small population size and limited distribution. Nonetheless, a series of self-pollination experiments that included within-occurrence crosses and crosses among occurrences demonstrated that *S. hookeri* shows moderately strong inbreeding depression. Reductions in population size could result in expression of inbreeding depression among progeny, such as reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species (68 FR 35950). Thus, owing to minimum numeric criteria being reached in four occurrences, *S. hookeri* has a moderate background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Schiedea hookeri* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *S. hookeri* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua or Schofield Barracks action areas (Service 2003a). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. hookeri* and associated native plants.

Ongoing Conservation Actions No information is available on conservation management for *Schiedea hookeri* since it was listed as endangered. However, about 128 individuals (30 percent of all remaining individuals) of this species occur action area in management units where they will benefit from population unit and/or ecosystem-level protection. The management units include Keaau and Kahanahaiki, which are not fenced; and Kaluakauila and Ohikilolo, which are fenced. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any *S. hookeri* within the preserve. This species is represented in *ex situ* collections that include nine cuttings in a nursery (Harold L. Lyon Arboretum) and 30 plants in a botanical garden (Waimea Valley Audubon Center) (Service 2005b).

Critical Habitat Description A total of 1,102 ha (2,724 ac) of critical habitat was designated in seven separate units for *Schiedea hookeri* on Oahu. Critical habitat was designated on State lands (Kaena Point State Park, Kuaokala, Mokuleia, and Waianae Kai Forest Reserves; and Pahole and Kaala Natural Area Reserves), Federal lands (Lualualei Naval Reservation), and private lands (Honouliuli Preserve). These seven critical habitat units provide habitat for eight populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. hookeri* (68 FR 35950).

The primary constituent elements of critical habitat include slopes, cliffs or cliff bases, rock walls, or ledges in diverse mesic or dry lowland forest often dominated by *Metrosideros polymorpha*, *Diospyros sandwicensis*, or *D. hillebrandii*; at elevations between 238 and 978 m (781 and 3,208 ft). In addition, all units contain one or more of the following associated native plant species: *Acacia koa*, *Alyxia oliviformis*, *Antidesma pulvinatum*, *Artemisia australis*, *Bidens torta*, *Carex meyenii*, *Carex wahuensis*, *Charpentiera tomentosa*, *Dodonaea viscosa*, *Elaeocarpus bifidus*, *Eragrostis grandis*, *Hibiscus* sp., *Leptecophylla tameiameiae*, *Melanthera tenuis*, *Pisonia sandwicensis*, *Pouteria sandwicensis*, *Psydrax odorata*, *Sida fallax*, or *Stenogyne* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the species' conservation (68 FR 35950).

Threats to the Critical Habitat See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area The four occurrences of *Schiedea hookeri* in the action area total about 128 individuals or about 30 percent of the species' range-wide distribution (U.S. Army Garrison 2006c) (see Table SB 33). Only the Kaluakauila occurrence is exceeding minimum numerical criteria for a stabilization population at 52 mature individuals. This occurrence is within a fenced ungulate exclosure; the other three action area occurrences are not fenced, and none of the action area occurrences are actively managed by the Army. *Schiedea hookeri* plants in the action area are located in areas at risk from training-related wildfire. About 92 individuals occur in the high fire risk zone, 20 individuals in the low fire risk zone and 6 in the very low fire risk zone. These individuals in fire risk zones represent about 31 percent of the species' total range-wide numbers; about 25 percent of the species' total range-wide numbers are located in the high fire risk zone. The Kaluakauila occurrence (52 individuals) is located within a zone of high fire risk, in an extremely dry area (U.S. Army Garrison 2005a). Thus, *S. hookeri* in the action area is characterized by one occurrence at minimum numeric levels to be categorized as a stabilization population unit that comprises 30 percent of all remaining individuals, most of which are located within high to very low fire risk zones, and by three occurrences with low numbers not reaching minimum numerical stabilization criteria and unknown trend.

<u>Status of the Critical Habitat in the Action Area</u> The action area contains a total of 30 ha (75ac) or three percent of the total critical habitat for *Schiedea hookeri*. Designated critical habitat is located within one unit in the northeastern portion of the action area. About three percent of critical habitat for this subspecies is located in an area at risk of training-related wildfire, with 6 ha (14 ac) located in the high fire risk zone and approximately 25 ha (61 ac) are in the very low fire risk zone. It is estimated that the critical habitat is located in an area with up to 75 percent native plant cover (K. Kawelo, pers. comm. 2004).

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Schiedea hookeri* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. This species is particularly threatened by competition with non-native weeds and by fire. The July 2003 prescribed fire at Makua burned within 20 m (66 ft) of *S. hookeri* plants in the Kaluakauila Management Unit, and burned approximately 2.4 ha (6 ac) of *S. hookeri* critical habitat (U.S. Army Garrison 2003b). About two percent of the total critical habitat designated for this species is at risk from training-related wildfire in the action area, with less than one percent located in the high fire risk zone. In addition, only 31 percent of all known individuals occur within the action area. Thus, *S. hookeri* in the action area has a moderate background risk of species extinction, and any additional threats are unlikely to eliminate the expectation of its long-term persistence.

<u>Conservation Needs of the Species and Critical Habitat in the Action Area</u> *Schiedea hookeri* non stabilization species by the Army because less than 50 percent of all remaining individuals are located within the action area, and there are three stabilization population units outside the action area. A post-fire revegetation plan and site-specific fuels modification plan are needed where *S. hookeri* is present in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area</u> No conservation actions are currently being implemented for *Schiedea hookeri* in the action area. However, this species benefits from ecosystem-level management in the fenced Kaluakauila and Ohikilolo Management Units, where non-native ungulates and weeds are controlled. In addition, fuels modification along the Kaluakauila ridgeline reduces the risk of fire in the management unit (K. Kawelo, pers. comm. 2004).

Status of the Species – *Schiedea kaalae* (No Common Name)

Species Description *Schiedea kaalae* is a short-lived perennial of the Caryophyllaceae (pink) family. It has a short woody caudex (perennial stem at the ground surface) less than 20 cm (8 in) tall, with short branches that trail along the ground and end in rosettes of thick, oppositely arranged leaves. The small, perfect flowers (with both male and female reproductive parts) are borne in open, branched clusters up to 40 cm (15.6 in) long. The fruit is a small capsule filled with tiny, dark seeds (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Schiedea kaalae* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for *S. kaalae* was designated on June 17, 2003 (68 FR 35950). The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Historic and Current Distribution *Schiedea* is a genus endemic to the Hawaiian Islands. Historic data indicate *Schiedea kaalae* was known from the north-central and south-central Waianae Mountains and the northern Koolau Mountains of Oahu. When listed in 1991, there were five occurrences in the Waianae Mountains and two occurrences in the Koolau Mountains that together totaled less than 100 individuals (56 FR 55770). In 2003, eight population units totaling 24 to 25 individuals indicated a steady decline for this species (Makua Implementation Team 2003). The latest information available indicates an increasing in detection due to more diligent survey effort and augmentation, with 10 population units totaling 235 individuals located on Federal, State, and private lands (68 FR 35950) (Table SB 34). Of these, 62 individuals are naturally occurring and 173 are augmentations from greenhouse-propagated stock. A new population unit was recently discovered at Kahana, and additional individuals were discovered at the Makua population unit (U.S. Army Garrison 2005b). None of the population units have reached the numeric targets for stabilization (defined as 50 mature individuals for short-lived perennials).

Demographic information in the wild is unknown, as *Schiedea kaalae* seedlings and immature plants are seldom seen, especially in Waianae population units. The apparent lack of recruitment is probably due to seedling predation by non-native slugs and snails (Makua Implementation Team 2003; U.S. Army Garrison 2004a, 2005b). The Nature Conservancy of Hawaii has propagated and outplanted *S. kaalae* from seed and cuttings, but no seedlings have been observed at those outplanting sites (U.S. Army Garrison 2004a). No information is available on the survival rate of immature outplantings. Individuals of this species are at risk from training-related wildfire in the Makua and Schofield Barracks Military Reservation action areas. Thus, *S. kaalae* is characterized by extremely low numbers that are increasing only by augmentation and occasional discovery of new occurrences.

Table SB 34. Range-wide Distribution of *Schiedea kaalae*.

Population Units	Number of Known Individuals					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Pahole*	--	--	3	1/0‡	2/0	0/3 [19/0]
Huliwai	--	--	1-2	0	0	0
Kahana (Koolau)*	--	--	--	11/0	5/2	5/2
Kaluaa and Waieli*	--	--	--	--	0/0 [40/25]	0/0 [72/44]
Kaipapau	--	--	--	2/0	0	0
Maakua (Koolau)*	--	--	4	4/0	16/0	16/0
Makaua (Koolau)	--	--	2	2/0	1/1	1/0 [0/1]
Mohiakea (SBMR)	--	--	1	1/0	1/0	1/0
North Kaluaa	--	--	2	0/0 [0/53]§	0	0
North Palawai	--	--	1	1/0	1/0	1/0
South Ekahanui* (North and South)	--	--	10	5/0 [0/75]	14/0 [0/46]	14/0 [56/0]
Total Individuals	<100	13	24-25	**155** (27/0)† [0/128]	**154** (40/3) [40/71]	**235** (38/5) [147/45]

Shaded population units are inside the action area.
SBMR = Schofield Barracks Military Reservation.
‡Total mature/immature individuals
*Stabilization population units
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003), Oahu Biological Opinion (Service 2003a)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b), T. Takahama (Hawaii Division of Forestry and Wildlife, pers. comm. 2006)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Schiedea kaalae* in the Waianae Mountains is consistently found on steep slopes and shaded sites in the understory of diverse mesic forest and wet forest, usually in gulch bottoms or low to mid gulch slopes, at elevations between 210 to 790 m (689-2,592 ft). It often grows on slopes with sparse groundcover and occasionally in cracks in rock embankments. In the Koolau Mountains, *S. kaalae* occurs in gulch bottoms and on lower gulch slopes within mesic to wet habitats, some of which are constantly wet from seeping water. Plants can grow on gentle to moderate slopes, steep rock embankments, and nearly vertical cliffs (56 FR 55770; Makua Implementation Team 2003). Where *S. kaalae* occurs in the same drainages as its relatives *S. hookeri*, *S. nuttallii*, *S. obovata*, and *S. pentandra*, it is usually found in the drier areas. *Schiedea kaalae* flowers from March through June. Cultivated plants are capable of self-pollination, but *S.*

kaalae is an outcrossing species that requires pollinators, probably insects, for fruit production (Wagner et al 2005). In the field, biologists have observed a non-native syrphid fly visiting the plants (Makua Implementation Team 2003). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information on *S. kaalae* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

<u>Threats to the Species</u> *Schiedea kaalae* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Schiedea kaalae* is particularly vulnerable to predation by non-native slugs and snails. One study noted, for example, that seedling mortality for the related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). In addition to the very low risk of training-related wildfire from military activities at Makua, one individual of *S. kaalae* is exposed to the risk of training-related wildfire at Mohiakea Gulch in the Schofield Barracks Military Reservation action area (Service 2003a).

Most importantly, occurrences of *Schiedea kaalae* are vulnerable to extirpation from naturally occurring events and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a, 1998a). In addition, *S. kaalae* and the related species *S. nuttallii* and *S. pentandra* are characterized by low isozyme variability and inbreeding due to small population size (Wagner et al 2005). Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. However, low levels of genetic diversity in *S. kaalae* populations may not be detrimental to the species as plants from populations that appear to have undergone repeated self-fertilization are vigorous in cultivation (Makua Implementation Team 2003). Nonetheless, the science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. kaalae* already is in a phase of "quasi-extinction," with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. kaalae* has a very high background risk of species extinction, and any additional threats could eliminate expectation of its long-term persistence.

<u>Conservation Needs of the Species</u> Conservation actions that should be implemented for the recovery of *Schiedea kaalae* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). The three population units identified for stabilization of *S. kaalae* are all located on State or private lands. The Army proposes to manage an additional two population units for stabilization at Maakua and Kahana, in the Koolau Mountains (U.S. Army Garrison 2005b). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. kaalae* and associated native plants.

Ongoing Conservation Actions   The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea kaalae*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Population units of *S. kaalae* are fenced in the Pahole, South Ekahanui, Kaluaa and Waieli, Makuaa, Mohiakea, and North Palawai population units; weeds are partially controlled only in the Mohiakea, North Palawai, and Kahana population units (U.S. Army Garrison 2005b). In addition, this species occurs in three management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Lower Kahana, which is not fenced; and Ekahanui and Pahole, which are fenced. The South Ekahanui population unit is augmented by The Nature Conservancy of Hawaii. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats, including the South Ekahanui population unit of *S. kaalae*. Seeds and cuttings have been taken from the recently discovered plants in the Kahana population unit for propagation and augmentation (U.S. Army Garrison 2005b).

Obtaining sufficient seed for genetic storage of *Schiedea kaalae* is difficult because plants do not produce much seed at one time. This species can be propagated from both seed and cuttings. Germination rates of fresh seeds vary from less than 15 percent to 75 percent (U.S. Army Garrison 2005b). The Nature Conservancy of Hawaii has propagated this species successfully from seed in the greenhouse, and has reintroduced plants to three sites in Honouliuli Preserve. Survivorship of these outplants appears good, but they have not yet produced any seedlings (U.S. Army Garrison 2005b). This species is represented in several *ex situ* collections, including one apical vegetative bud in micropropagation (Harold L. Lyon Arboretum), 23 cuttings in a nursery (Harold L. Lyon Arboretum), 17 plants in a nursery (Harold L. Lyon Arboretum), nine plants in a botanical garden (Waimea Valley Audubon Center), 598 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 6,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 193 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description   A total of 1,103 ha (2,726 ac) in six separate units was designated as critical habitat for *Schiedea kaalae* on Oahu. Critical habitat was designated on State lands (Pahole Natural Area Reserve, Mokuleia, Hanuula, and Kaipapau Forest Reserves, and Sacred Falls and Kahana Valley State Parks) and private lands (Honouliuli Preserve and others). These critical habitat units provide habitat for 10 populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. kaalae* (68 FR 35950).

The primary constituent elements of critical habitat include steep slopes, cliffs, stream banks, or deep shade in diverse mesic or wet forests at elevations between 64 and 904 m (210 and 2,965 ft). In addition, all units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Boehmeria grandis*, *Charpentiera* sp., *Claoxylon sandwicense*, *Cyrtandra calpidicarpa*, *Cyrtandra laxiflora*, *Diospyros hillebrandii*, *Diplazium arnottii*, *Diplazium sandwichianum*, *Dryopteris unidentata*, *Freycinetia arborea*, *Hedyotis acuminata*, *Nothocestrum longifolium*, *Pipturus albidus*, *Pisonia sandwicensis*, *Pisonia umbellifera*, *Pouteria sandwicensis*, *Psychotria hathewayi*, *Selaginella arbuscula*, or *Xylosma hawaiiense*. The plant community, associated species, and elevations are a barometer for such things as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat   See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area   The action area includes 22 (19 mature, 3 immature) *Schiedea kaalae* plants in the Pahole population unit or about nine percent of the species' total range-wide numbers (see Table SB 34). In 2003, there were three individuals in this population unit (Makua Implementation Team 2003; U.S. Army Garrison 2005b). The 22 plants are within the fenced Pahole Management Unit where ungulates, but not invasive weeds, are controlled by the Hawaii Division of Forestry and Wildlife (U.S. Army Garrison 2004a). This part of the Pahole Natural Area Reserve is in a zone of very low fire risk. Thus, *S. kaalae* in the action area is characterized by one population unit that has increased in number to 22 individuals or about nine percent of all remaining individuals of this species.

Status of the Critical Habitat in the Action Area   The action area contains a total of 150 ha (372 ac) or 14 percent of the total critical habitat designated for *Schiedea kaalae* on Oahu and in the state. Critical habitat is located on State land (Pahole Natural Area Reserve) in the northeastern part of the action area. This critical habitat is part of a total 425 ha (1,051 ac) critical habitat unit that extends beyond the action area and provides habitat for two populations of 300 mature, reproducing individuals each. About 14 percent of critical habitat for this species is located in an area at risk from training-related wildfire, with almost no critical habitat located in the high fire risk zone. Approximately 0.0 ha (trace <0.1 ac.) are in the high fire risk zone, 7.4 ha (18.2 ac) are in the low fire risk zone and 143.1 ha (353.6 ac) are in the very low fire risk zone. It is estimated that almost half of the critical habitat in the action area contains less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to the Species and Critical Habitat in the Action Area   The primary threats to *Schiedea kaalae* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The greatest limiting factor to the stabilization of *S. kaalae* is slug predation of seedlings (U.S. Army Garrison 2005b). The action area critical habitat represents about 14 percent of total critical habitat at risk from training-related fire, with none in the high fire risk zone. Although the species as a whole is extremely at risk, the 22 plants in the very low fire risk zone of the action area represent only about nine percent of the species' range-wide distribution. Thus, *S. kaalae* in the action area has a relatively low background risk of species extinction, and any additional threats are unlikely to affect the species' long-term persistence outside the action area.

Conservation Needs of the Species and Critical Habitat in the Action Area   The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Schiedea kaalae* because no population units exceeding minimum criteria for stabilization exist outside the action area (Makua Implementation Team 2003). Three population units have been identified for stabilization of *S. kaalae*: Pahole within the action area, and North Kaluaa and South Ekahanui outside the action area. In addition, the Army has proposed two additional, backup population units for stabilization: Kahana and Maakua in the Koolau Mountains outside the action area. Army Natural Resources Staff have not seen the *S. kaalae* plant in the Pahole population unit within the action area and long-term access issues with the Hawaii Division of Forestry and Wildlife are unclear (U.S. Army Garrison 2005b). Post-fire revegetation plans and site-specific fuels modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *S. kaalae* in the action area. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species in the Action Area</u> The Pahole population unit is located within the fenced Pahole Management Unit, and is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). About 10 percent of the mature individuals of this species in the action area are within a fenced portion of the Pahole Management Unit. In general, sufficient collections for genetic storage have been difficult to achieve as plants produce few seeds at a time. Genetic storage goals are two percent complete, with 21 plants from all nine population units combined towards fulfilling the goals outlined in the Makua Implementation Plan. There are also 15 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Schiedea nuttallii* (No Common Name)

<u>Species Description</u> *Schiedea nuttallii* is a short-lived perennial of the Caryophyllaceae (pink family). It is an erect subshrub (stems woody at the base) up to 1.5 m (4.9 ft) tall with purple-tinged, oppositely-arranged leaves 5 to 13 cm (2.0 to 5.1 in) long. The small, perfect flowers (with both male and female reproductive parts) are borne in terminal clusters 20 to 25 cm (7.8 to 9.8 in) long. The tiny hard, black seeds are contained within small papery capsules 2.5 to 3.5 mm (0.1 to 0.14 in) long (Wagner et al 1999; Makua Implementation Team 2003).

<u>Listing Status</u> *Schiedea nuttallii* was federally listed as endangered on October 10, 1996 (61 FR 53108), and was State listed as endangered at the same time. A recovery plan for multi-island plants included the listed taxon, then classified as comprised of plants from Kauai, Oahu, Molokai, and Maui (Service 1999a). Critical habitat for the listed taxon was designated for Oahu on June 17, 2003 (68 FR 35950); for Molokai on March 18, 2003 (68 FR 12982); and for Kauai on February 27, 2003 (68 FR 9115). The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Previous Biological Opinions for military training at Makua cover Oahu occurrences of the listed taxon, and the Makua Implementation Plan covers the Waianae "subspecies" (Makua Implementation Team 2003). When listed, *Schiedea nuttallii* was considered to include historical occurrences on Kauai, Oahu, Molokai, and Maui, with occurrences still existing on Kauai and Oahu (61 FR 53108). The Makua Implementation Plan noted the species' taxonomy was under revision, and likely would be reclassified as two subspecies, with the Oahu and Maui plants as the subspecies *nuttallii* and newly discovered plants on Molokai as a new subspecies (Makua Implementation Team 2003). However, the recently revised taxonomy of the genus *Schiedea* treats *S. nuttallii* as a full species comprised of Oahu, Molokai (recently extirpated), and Maui (historic) occurrences (Wagner et al 2005). The Kauai occurrence formerly considered as *S. nuttallii* is now recognized as two species endemic to Kauai, *S. perlmanii* and *S. kauaiensis*. The recently discovered occurrence on Molokai is recognized as a new species, *S. laui*. This Biological Opinion considers *S. nuttallii* as defined by Wagner et al (2005), i.e., as comprised of currently existing occurrences on Oahu. The status of this newly classified species is identical to that of Oahu occurrences of the federally listed taxon.

<u>Historic and Current Distribution</u> *Schiedea* is a genus endemic to the Hawaiian Islands. Historic data indicate considerable range restriction in *Schiedea nuttallii*, which was one of the most widely distributed species in the genus with documented occurrences on Oahu, Molokai (recently extirpated), and West Maui (historical) (Wagner et al 2005). On Oahu, *S. nuttallii* was recorded from scattered occurrences throughout the Waianae Mountains and the southeastern Koolau Mountains. The species is now restricted to the northern Waianae Mountains; plants in the southern Waianae Mountains have not been seen since the late 1970s (Makua Implementation Team 2003). Plants are located on Federal and State lands (68 FR 35950). The Ekahanui Gulch occurrence at the privately owned Honouliuli Preserve, which was noted when the species was listed, has not been seen since 1978 (Service 1999a).

Consistent monitoring survey data for this species are available only since 2003, when *Schiedea nuttallii* was characterized as "clearly declining" with 50 total individuals in three population units (Makua Implementation Team 2003). Currently, this species consists of only two known population units totaling 94 individuals (Table SB 35). The Kahanahaiki portion of the Kahanahaiki to Pahole population unit is located on Makua. The Pahole portion of the Kahanahaiki to Pahole population unit and the Kapuna-Keawapilau Ridge population unit are located in Pahole Natural Area Reserve. The Kahanahaiki to Pahole population unit currently contains 80 mature individuals, and may meet the numerical criterion for stability (defined as 50 mature, reproducing individuals for short-lived perennials). This population unit increased from about 48 total individuals in 2003 to 91 total individuals in 2006, primarily owing to Army augmentation efforts (Makua Implementation Team 2003, U.S. Army Garrison 2006d). About 50 percent of all currently existing individuals are augmentations from greenhouse-propagated stock, including about 52 percent of all mature individuals and 36 percent of all immature individuals. The Kahanahaiki to Pahole population unit is located within low to very low zones at risk from training-related wildfire.

Demographic data in the Kahanahaiki to Pahole population unit include limited recruitment. However, both augmented and naturally occurring immature plants are attacked by invertebrates and are not vigorous (U.S. Army Garrison 2004a, 2005b). Although total numbers have increased from 60 to 94 since 2003, the total number of naturally occurring individuals in the Kapuna-Keawapilau Ridge population unit has remained at only three individuals. Thus, *Schiedea nuttallii* is characterized by low numbers of known individuals with only two existing population units, including one that has met minimum numerical criteria for stabilization but is being sustained primarily through augmentation.

Table SB 35. Range-wide distribution of *Schiedea nuttallii.*

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Numbers of Known Individuals</th></tr>
<tr><th>1996
(1)</th><th>1999
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kahanahaiki*</td><td>--</td><td>28</td><td>21/12</td><td rowspan="2">31/8‡
[13/5]§</td><td rowspan="2">23/8
[35/10]</td><td rowspan="2">37/7
[43/4]</td></tr>
<tr><td>Pahole*</td><td>2</td><td>20-50</td><td>14-15</td></tr>
<tr><td>Kapuna-Keawapilau Ridge*</td><td>--</td><td>--</td><td>2/1</td><td>3/0</td><td>3/0</td><td>3/0</td></tr>
<tr><td>Ekahanui Gulch</td><td>--</td><td>2</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>Makaha*</td><td>--</td><td>--</td><td>--</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Total Individuals</td><td>**25**</td><td>**50-80**</td><td>**50-51**</td><td>**60**
(34/8)
[13/5]</td><td>**79**
(26/8)
[35/10]</td><td>**94**
(40/7)
[43/4]</td></tr>
</table>

Shaded population units are inside the action area.
*Stabilization population units
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (61 FR 53115)
(2) Recovery Plan (Service 1999a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Schiedea nuttallii* occurs in the understory of diverse mesic forest at elevations between 400 and 730 m (1,312 and 2,395 ft). It typically grows on steep rock walls and forested slopes of north-facing gulches in *Acacia koa-Metrosideros polymorpha* lowland mesic forest and *Metrosideros polymorpha-Dodonaea viscosa* forest (68 FR 35950). Flowers and fruits are abundant in the wet season and less so throughout the year. *Schiedea nutttallii* is an outcrossing species that requires pollinators, probably insects, for fruit production (Wagner et al 2005). Plant longevity probably is similar to that of other small, semi-woody shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *S. nuttallii* in the wild is unknown, including longevity, number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal in the wild, vegetative reproduction in the wild, and specific environmental requirements.

Threats to the Species *Schiedea nuttallii* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea nuttallii* is particularly vulnerable to predation by non-native slugs and snails. Seedlings have been observed in wild populations, but recruitment is reduced because of these alien invertebrates. Augmented *S. nuttallii* individuals seem to survive the initial outplanting transition but are subsequently weakened by invertebrate injury (Makua Implementation Team 2003). One study noted, for example, that seedling mortality for the related species *S. obovata* doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). This species also may be threatened by the black twig borer *Xylosandrus compactus*, which causes slight to severe defoliation and reduced plant vigor that may kill branches or the entire plant (68 FR 35950; U.S. Army Garrison 2004a). Black twig borer predation would be of particular concern for *S. nuttallii* because no control methods are available that do not also harm native scolytid beetles. Regarding fire vulnerability, *S. nuttalli* is a small, understory herbaceous plant less than 1.5 m (4.9 ft) tall with stems that are woody only at the base. Whether *S. nuttallii* resprouts or regenerates from buried seeds after fire is unknown, but it is probably similar to most native Hawaiian plants in lack of resistance or tolerance to fire.

Most importantly, occurrences of *Schiedea nuttallii* are vulnerable to extirpation from naturally occurring events such as landslides and/or reduced reproductive vigor due to small population size and limited distribution (61 FR 53108; 68 FR 35950; Service 1999a). In addition, *S. nuttallii* and the related species *S. kaalae* and *S. pentandra* are characterized by low isozyme variability and inbreeding due to small population size (Wagner et al 2005). Reductions in population size could result in expression of inbreeding depression among progeny, for example in reduced reproductive vigor, with potentially deleterious consequences for the long-term persistence of this species. The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern, *S. nuttallii* already is in a phase of "quasi-extinction" with numbers that have declined to the point where demographic stochasticity alone can result in extirpation. Thus, *S. nuttallii* has a very high background risk of species extinction and any additional threats could eliminate expectation of its long-term persistence.

<u>Conservation Needs of the Species</u> Conservation actions that should be implemented for the recovery of *Schiedea nuttallii* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Research on slug control in forest settings is needed to find ways to reduce invertebrate threats to *S. nuttallii* and associated native plants.

<u>Ongoing Conservation Actions</u> The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea nuttallii*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). The Army has been augmenting occurrences in the Kahanahaiki and Pahole population unit since 2003. In addition, this species is located in occurrences over three management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Upper Kapuna, which is not fenced; and Kahanahaiki and Pahole, which are fenced.

Schiedea nuttallii has been successfully propagated by tissue culture from seed, and from cuttings. The germination rate of fresh seed is about 50 percent, and the success rate of cuttings is 10 to 50 percent. Seed can be stored with little or no decrease in viability, but germination trials have not yet been conducted because so few plants are available to provide material (U.S. Army Garrison 2005b). Both remaining population units, Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge, are represented in *ex situ* collections (U.S. Army Garrison 2005b). In 2005, these *ex situ* collections included 108 cuttings in nurseries (Army Environmental Division,Oahu, and Harold L. Lyon Arboretum), 54 ungerminated seeds in a nursery (Harold L. Lyon Arboretum), 1,300 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 20 seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b).

<u>Critical Habitat Description</u> A total of 1,256 ha (3,103 ac) of critical habitat, in six separate units on three islands, was designated for *Schiedea nuttallii*, including 709 ha (1,753 ac) in three units on Oahu. Critical habitat on Oahu was designated on State lands (Mokuleia Forest Reserve, and Pahole and Kaala NATURAL AREA RESERVEs) and on private lands (Honouliuli Preserve) (68 FR 35950). The three critical habitat units on Oahu provide habitat to support six populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. nuttallii* (68 FR 35950).

The primary constituent elements of critical habitat on Oahu include rock walls, forested slopes, or steep walls in *Acacia koa-Metrosideros polymorpha* lowland mesic forest or *Metrosideros polymorpha-Dodonaea viscosa* forest at elevations between 408 and 1,072 m (1,338 and 3,516 ft). In addition, all units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma platyphyllum*, *Bidens torta*, *Cibotium chamissoi*, *Coprosma* sp., *Cyanea longiflora*, *Hedyotis terminalis*, *Ilex anomala*, *Machaerina* sp., *Peperomia* sp., *Perrottetia sandwicensis*, *Pipturus* sp., and *Psydrax odorata*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

<u>Threats to the Critical Habitat</u> See introduction to "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

<u>Status of the Species in the Action Area</u> According to U.S. Army Garrison (2006d), all known individuals of *Schiedea nuttallii* are located within the previously-designated action area, in the Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge population units (see Table SB 35); see the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. However, we have information that indicates the Kapuna-Keawapilau Ridge population unit is actually located outside the current action area (M. Mansker, pers. comm. 2005). The Kahanahaiki to Pahole population unit currently contains about 91 total individuals, or 97 percent of all remaining individuals of this species. This population unit contains 80 mature individuals and could be considered meeting numerical stabilization targets; however, threat control and genetic storage goals are not yet complete. This population unit increased from 48 total individuals in 2003 to 91 total individuals in 2006, owing primarily to Army augmentation efforts. About 52 percent of all individuals in this population unit are augmentations, including many nursery-propagated seedlings and clones (cuttings). The vigor of outplanted individuals ranges from healthy to poor and survivorship ranges from 50 to 75 percent; so far, there is no regeneration at augmented sites (U.S. Army Garrison 2005b). The Kapuna-Keawapilau Ridge population unit has remained static at three individuals since 2003. Plants of this species in action area are located in zones at risk of training-related wildfire. About 84 individuals occur in the low fire risk zone and 10 individuals in the very low fire risk zone. Thus, *S. nuttallii* in the

action area is characterized by one population unit meeting minimum numerical criteria for stabilization but that is increasing primarily by augmentation, with 100 percent of all remaining individuals at low and very low risks of training-related wildfire.

Status of the Critical Habitat in the Action Area The action area contains a total of 199.7 ha (493.5 ac), or 16 percent of the total critical habitat for *Schiedea nuttallii* on Oahu. Critical habitat was designated for this species on other islands in 2003; however, plants on Kauai and Maui are no longer considered within the taxon *S. nuttallii* (Wagner et al 2005). Designated critical habitat on Oahu is located within one unit in the northeastern portion of the Makua action area. This critical habitat is a portion of a larger 527 ha (1,304 ac) critical habitat unit that extends outside the action area boundary and provides habitat for four populations of *S. nuttallii*. About 16 percent of critical habitat for this species on Oahu is located in an area at risk of training-related wildfire, with 0.2 ha (0.6 ac) located in the high fire risk zone, 17.1 ha (42.3 ac) in the low fire risk zone, and 182.2 ha (450.2 ac) in the very low fire risk zone. It is estimated that nearly one-half of the critical habitat in the Makua action area is found in areas comprised of 50 to 75 percent native plant cover and another one-quarter is found in areas with greater than 75 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Schiedea nuttallii* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea nuttallii* in the action area is particularly vulnerable to predation by non-native slugs and snails, and may be susceptible to predation by the black twig borer (U.S. Army Garrison 2004a). About 16 percent of critical habitat for this species on Oahu is located in an area at high, low, and very low risks of training-related wildfire. Thus, because 100 percent of all known remaining individuals occur within the action area, *S. nuttallii* in the action area has a very high background risk of species extinction and any additional threats could eliminate the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Schiedea nuttallii* because more than 50 percent of all known individuals occur within the action area and no population units meeting minimum numeric criteria for stabilization exist outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Three population units have been identified for expedited stabilization of *S. nuttallii*: Kahanahaiki to Pahole within the action area, and Kapuna-Keawapilau Ridge and Makaha outside the action area. The Makaha population unit will be established through reintroduction after an ungulate-exclosure fence is built in 2007. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *S. nuttallii* and associated native plants. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge population units, which contain all of the total remaining individuals of *Schiedea nuttallii*, are being managed for stabilization as specified in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). These individuals are located in the Kahanahaiki (subunit II) and Pahole Management Units, which are fenced; and in the Upper Kapuna Management Unit, which is not fenced. All but one wild site in the Pahole part contain good-quality habitat within fenced exclosures, are augmented with outplanted individuals, and are partially controlled to reduce cover of non-native weeds. A total of about 332.3 ha (821.1 ac) of critical habitat for this species is located within management units both within and outside of the action area (East Makaleha, Ekahanui, Kahanahaiki, Kaluaa and Waieli, Pahole, Upper Kapuna, West Makaleha). About 170.5 ha (421.1 ac) of the total critical habitat that is within management units is located inside the action area (Kahanahaiki, Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were 11 percent complete, with 11 plants from both remaining population units combined towards meeting the goals outlined in the Makua Implementation Plan, and 23 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Schiedea obovata* (No Common Name)

Species Description *Schiedea obovata* is a short-lived perennial of the Caryophyllaceae (pink family). It is an erect subshrub (stems woody at the base) up to 1 m (3.3 ft) tall, with oppositely arranged, elliptic leaves 4 to 11 cm (1.6 to 4.3 in) long. The small, perfect flowers (with both male and female reproductive parts) lack petals and are borne in axillary clusters. The berry-like seed capsules are covered by fleshy purple calyx lobes and contain many tiny black seeds (Wagner et al 1999; Makua Implementation Team 2003).

Listing Status *Alsinidendron obovatum* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). The recently revised taxonomy of *Schiedea* incorporates species previously classified as *Alsinidendron*, and *Alsinidendron obovatum* has been reclassified as *Schiedea obovata* (Wagner et al 2005). The status of *Schiedea obovata* is identical to that of *Alsinidendron obovatum*, the federally listed taxon. The genus *Schiedea* (including species formerly classified as *Alsinidendron*) has the highest proportion of endangered taxa in Hawaii (Wagner et al 2005), with 19 of 35 taxa (54 percent) listed as endangered and three identified as candidates for listing (Service 2006a).

Historic and Current Distribution *Schiedea* is a genus endemic to the Hawaiian Islands. Historic data indicate that *Schiedea obovata* has declined significantly in the last 20 years (Makua Implementation Team 2003). Historically, this species was known from the northern and southern parts of the Waianae Mountains. When the species was listed in 1991, two occurrences totaling about 100 individuals were known, in Kapuna Gulch and Pahole Gulch (56 FR 55770). Since then, more occurrences have been discovered, but by 2003 plants were no longer found at some locations (Makua Implementation Team 2003). In late 2003, a new population unit was discovered in North West Makaleha, near a historical Keawapilau population, but surveys to locate other population units in the southern Waianae Mountains were unsuccessful (U.S. Army Garrison 2004a. Currently, two population units, Kahanahaiki to Pahole and Keawapilau to West Makaleha, total 389 individuals located on Federal and State lands (68 FR 35950) (Table SB 36). The Kahanahaiki to Pahole population unit has met numerical criteria for stabilization (defined for this species as 100 mature individuals per population unit) (Makua Implementation Team 2003). The existing population units also are located within low and very low fire risk zones for training-related wildfire.

Demographic data indicate *Schiedea obovata* is increasing in numbers only due to augmentation efforts and the discovery of a new population unit in North West Makaleha. About 82 percent of all of individuals are augmentations from greenhouse-propagated stock. Recruitment of seedlings and immature plants into the mature population is limited by predation by non-native slugs and snails that feed on and damage leaves and stems (Makua Implementation Team 2003; U.S. Army Garrison 2004a; U.S. Army Garrison 2005b). One study noted, for example, that seedling mortality doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). Furthermore, slugs have the potential to completely halt seedling regeneration in several sites (U.S. Army Garrison 2004a, 2005b). Thus, *S. obovata* is characterized by declining in the current range and two existing population units with low numbers, of which one is exceeding minimum numerical criteria for stabilization and increasing through augmentation and discovery of new individuals.

Table SB 36. Range-wide distribution of *Schiedea obovata*.

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Number of Known Individuals</th></tr>
<tr><th>1991
(1)</th><th>1995-1998
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kahanahaiki*</td><td>--</td><td>--</td><td>0</td><td rowspan="2">0/0[‡]
[65/25][§]</td><td rowspan="2">0/0
[58/183]</td><td rowspan="2">0/0
[103/190]</td></tr>
<tr><td>Pahole*</td><td>--</td><td>--</td><td>0</td></tr>
<tr><td>Keawapilau*</td><td>--</td><td>--</td><td>0</td><td rowspan="3">21/12</td><td rowspan="3">42/34</td><td rowspan="3">44/27
[11/14]</td></tr>
<tr><td>North West Makaleha*</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td>West Makaleha*</td><td>--</td><td>--</td><td>3</td></tr>
<tr><td>Makaha*</td><td>--</td><td>--</td><td>--</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Other Locations</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>13</td></tr>
<tr><td>Total Individuals</td><td>100</td><td>11-12</td><td>3-10</td><td>123
(21/12)[†]
[65/25]</td><td>317
(42/34)
[58/183]</td><td>389
(44/27)
[114/204]</td></tr>
</table>

Shaded population units are inside the action area.
*Stabilization population units
[‡]Total mature/immature individuals
[†]Total (mature/immature)
[§][augmented and or reintroduced]

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c)

<u>Ecology</u> *Schiedea obovata* occurs on ridges and slopes in lowland diverse mesic forests dominated by *Acacia koa* and *Metrosideros polymorpha*, at elevations of 560 to 760 m (1,837 to 2,494 ft). Plants generally flower after two years of growth, and are normally self-fertilizing (Makua Implementation Team 2003). Flowers and fruit are produced year-round, especially in

response to rainfall during winter and spring. Seed dispersal mechanism is unknown, although the plant's "false berry" possibly may attract fruit-eating birds that may disperse the seeds (Makua Implementation Team 2003). Plants survive 3 to 6 years, or less under drought conditions (Service 1995a, Service 1998a). Population units in the wild have been known to disappear for a number of years and then reappear after large rainfall events, apparently owing to persistence of seeds in the soil seed bank (U.S. Army Garrison 2004a). Other demographic information for *S. obovata* in the wild is unknown, including number of seeds produced, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Schiedea obovata* was listed as endangered because of major, ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea obovata* is particularly vulnerable to predation by non-native slugs and snails (Makua Implementation Team 2003; U.S. Army Garrison 2005b). The decline and possible extirpation of the southern Waianae population units of *S. obovata* are partially attributed to residential development, establishment of military installations, reforestation with non-native trees in the early 1900s, and trampling and illegal collecting by people (Makua Implementation Team 2003). Most importantly, population units of *S. obovata* are vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a, 1998a). Because *S. obovata* is thought to be a facultative self-pollinator, inbreeding depression may not be significant (U.S. Army Garrison 2004a). This species experiences large population fluctuations related to drought and its natural recruitment is severely reduced by slug predation (U.S. Army Garrison 2005c). The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). Thus, *S. obovata* has a very high background risk of species extinction and any additional threats could reduce expectation of its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Schiedea obovata* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain stabilization criteria for short-lived perennials. However, because of the common, large declines or fluctuations in numbers of *S. obovata*, the Makua Implementation Team (2003) identified a stabilization target of at least 100 mature individuals for each population unit of this species. An increased stabilization criterion is needed because any adverse disturbance during a major low point in a population unit's fluctuation could extirpate that unit. In addition to stabilizing the two existing population units, a third population unit must be established by reintroduction and managed for stabilization outside the action area. Research on slug control in forest settings is needed to find ways to reduce this threat to *S. obovata* and associated native plants.

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Schiedea obovata*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species occurs in the Kahanahaiki, Pahole, and West Makaleha Management Units where it will benefit from population unit and/or ecosystem-level protection. The Army and the Hawaii Division of Forestry and Wildlife have been outplanting this species within fenced exclosures since 1999. The Kahanahaiki to Pahole population unit is located within the fenced Kahanahaiki and Pahole Management Units, and the North West Makaleha site within the Keawapilau to West Makaleha population unit is fenced. Fence construction is planned for the entire West Makaleha Management Unit in 2007. Invasive weeds are controlled at extant *S. obovata* sites, but not at historical sites.

Schiedea obovata seed can be successfully stored and remain viable for several years, and outplantings have been successful (U.S. Army Garrison 2005b). In 2005, this species was represented in the following *ex situ* collections: one cutting in a nursery (Army Environmental Division, Oahu), 14 plants in a botanical garden (Waimea Valley Audubon Center), 161 seeds in micropropagation (Harold L. Lyon Arboretum), 236,814 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 13 seedlings in micropropagation (Harold L. Lyon Arboretum) (Service 2005b).

Critical Habitat Description A total of 232 ha (574 ac) of critical habitat was designated for *Schiedea obovata* on June 17, 2003, in three separate units. Critical habitat was designated on State lands (Mokuleia, Nanakuli, and Waianae Kai Forest Reserves, and Pahole Natural Area Reserve), to provide habitat for seven populations. To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. obovata* (68 FR 35950).

The primary constituent elements of critical habitat include ridges and slopes in lowland diverse mesic forest dominated by *Acacia koa* and *Metrosideros polymorpha* at elevations between 477 and 943 m (1,565 and 3,093 ft). In addition, all units contain one or more of the following associated native plant species: *Alyxia oliviformis*, *Antidesma platyphyllum*, *Bidens torta*, *Cibotium chamissoi*, *Coprosma* sp., *Cyanea longiflora*, *Hedyotis terminalis*, *Ilex anomala*, *Machaerina* sp., *Peperomia* sp., *Perrottetia sandwicensis*, *Pipturus* sp., and *Psydrax odorata*. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels which are primary constituent elements of the habitat required for the species' conservation.

Threats to the Critical Habitat See introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area All known individuals of *Schiedea obovata* are located within the action area, in the Kahanahaiki to Pahole and Keawapilau to West Makaleha population units (see Table SB 36). The Kahanahaiki to Pahole population unit, with 103 mature individuals, may be considered exceeding numerical criteria for stabilization (defined for this species as 100 mature individuals per population unit), but threats are not adequately controlled and genetic storage is not complete. All naturally occurring *S. obovata* plants in the

Kahanahaiki, Pahole, and Keawapilau sites had disappeared by 2001 and no seedlings have regenerated from the soil seed bank (U.S. Army Garrison 2004a). All current individuals in the Kahanahaiki to Pahole population unit are augmentations from greenhouse-propagated stock. The Keawapilau to West Makaleha population unit has increased from 3 individuals in 2003 to 96 in 2006, due to augmentation and discovery of new subpopulations within the population unit. About 74 percent of total individuals in this population unit are naturally occurring, not augments. The Army has augmented wild populations at three sites (Kahanahaiki, Pahole, and West Makaleha). High seedling recruitment has resulted from plants reintroduced at Pahole. Plants reintroduced at Kahanahaiki are less vigorous, perhaps reflecting differences in genetic founder material (U.S. Army Garrison 2005b). All plants within the action area are located in areas at risk of training-related wildfire. About 91 individuals occur in the low fire risk zone and 298 individuals in the very low fire risk zone. Thus, *S. obovata* in the action area is characterized by one population unit meeting numerical criteria for stabilization and one population unit not exceeding numerical criteria that contain all remaining individuals in low and very low fire risk zones, and by numbers that are increasing almost entirely by augmentation and discovery of new individuals.

Status of the Critical Habitat in the Action Area The action area contains a total of 164.5 ha (406.4 ac), or 71 percent, of the total critical habitat for *Schiedea obovata*. Most of the critical habitat is located on State land in the northeastern portion of the action area. This critical habitat is part of a total 176 ha (436 ac) critical habitat unit that extends beyond the action area and provides potential habitat to support five populations of 300 mature, reproducing individuals each. Critical habitat for this species in the action area is located in an area at risk of training-related wildfire, with 0.04 ha (0.1 ac) in the high fire risk zone, 14.5 ha (35.9 ac) in the low fire risk zone and 149.9 ha (370.4 ac) in the very low fire risk zone. It is estimated that almost the entire critical habitat is within areas that contain more than 50 percent native plant cover (K. Kawelo, pers. comm. 2004; Service 2004a).

Threats to the Species and Critical Habitat in the Action Area The primary threats to *Schiedea obovata* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section, and are tabulated in Appendix E. *Schiedea obovata* in the action area is particularly vulnerable to predation by non-native slugs and snails. The action area critical habitat in the high to low and very low fire risk zones represents about 71 percent of total critical habitat for this species. Thus, because all known individuals occur within the action area and all are within fire risk zones, *S. obovata* in the action area has a very high background risk of species extinction and any additional threats could reduce the expectation of its long-term persistence.

Conservation Needs of the Species and Critical Habitat in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrsion 2005a) includes *Schiedea obovata* because more than 50 percent of all known individuals occur within the action area, and population units exceeding numerical criteria for stabilization do not exist outside the action area. Furthermore, because of its low numbers, this species is considered particularly at risk from project-related impacts and is included in Army plans for expedited stabilization. Three population units have been identified for stabilization of *S. obovata*: Kahanahaiki to Pahole and Keawapilau to West Makaleha within the action area, and Makaha, to be reintroduced outside the action area after fence construction. Fencing and control of feral ungulates is needed for the West Makaleha and Upper Kapuna Management Units, along with additional control of non-native vegetation. Post-fire revegetation plans and site-specific fuel modification are needed where individuals and critical habitat are located in the action area. Slug control research is needed to find ways to reduce threats to *S. obovata* and associated native plants. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area</u> The Kahanahaiki to Pahole population unit and Keawapilau to West Makaleha population units are being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). Within the Kahanahaiki to Pahole population unit, the Army has augmented the Kahanahaiki occurrence and the State has augmented the Pahole occurrence, and both areas are fenced. This species in the action area also occurs at a fenced site within the West Makaleha Management Unit. Weeds are controlled around extant *Schiedea obovata* sites in both population units. A total of about 183.5 ha (453.5 ac) of critical habitat for this species is located within management units both within and outside of the action area (Makaha, Pahole, Palikea, Upper Kapuna, West Makaleha). About 152.4 ha (376.6 ac) of the total critical habitat that is within management units is located inside the action area (Pahole, Upper Kapuna, West Makaleha). As of 2005, genetic storage goals were 31 percent complete, with 31 plants from both population units combined towards meeting the goals outlined in the Makua Implementation Plan, and 12 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species – *Silene lanceolata* (No Common Name)

<u>Species Description</u> *Silene lanceolata*, a member of the Caryophyllaceae (pink) family, is a short-lived perennial. Flowers are white with deeply lobed, clawed petals, and stems are 15 to 50 cm (6 to 20 in) long and woody at the base. Leaves are narrow, smooth and fringed with hairs. This species is distinguished from other Hawaiian members of the genus by its erect stem, terminal inflorescence, and length of the calyx, clawed petals, and carpophore (ovary structure) (Wagner et al 1999).

<u>Listing Status</u> *Silene lanceolata* was federally listed as endangered on October 8, 1992 (57 FR 46325) and state listed as endangered at the same time. A recovery plan was prepared for this species in September 1996 (Service 1996). Critical habitat was designated for *S. lanceolata* on Molokai and Oahu in 2003 (68 FR 12982; 68 FR 35950).

<u>Historic and Current Distribution</u> Historically, *Silene lanceolata* was found on Kauai, in Makua Valley on Oahu, below Puu Kolekole in east Molokai, Maunalei on Lanai, and on Mauna Kea on Hawaii. *Silene lanceolata* is currently known from a total of 2,640 individuals on the islands of Molokai, Oahu, and Hawaii. On Molokai, a single occurrence of approximately 100 individuals was reported in 1987 on private land near Puu Kolekole. On Hawaii, it is found on the Army's Pohakuloa Training Area in Kipuka Kalawamauna, Puu KeeKee, and Kipuka Alala. These three occurrences are distributed over a distance of approximately 15 km (9 mi) and total more than 2,500 individuals. On Oahu, this species has increased from approximately 40 known individuals in five occurrences in mid to late 1990s to 157 known individuals in two occurrences

in 2006 (U.S. Army Garrison 1999a, U.S. Army Garrison 2006c) (Table SB 37). Thus, *S. lanceolata* is characterized by two population units at low numbers, and an overall abundance on Oahu that appears to be increasing but is due in part to increased monitoring efforts.

Table SB 37. Range-wide Distribution of *Silene lanceolata.*

Population Units	Number of Known Individuals					
	1991 (1)	**1996** (2)	**1999** (3)	**2003** (4)	**2005** (5)	**2006** (6)
Ohikilolo	--	40	40	--	24	11/6
Waianae Kai	--	--	--	12	80/60‡	80/60
Total Population Units on Oahu	--	1	1	4	2	2
Total Individuals on Oahu	--	**40**	**40**	**62**	**164**	**157** (91/66)
Total PopulationUnits State-wide	3	5	5	--	3	--
Total Individuals State-wide	100-130	<1500	>2640	--	**664 -1164** (604-1,104/60)†	--

Shaded occurrences are inside the action area.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR 55770)
(2) Molokai Recovery plan (Service 1996)
(3) Makua Endangered Species Mitigation Plan (Service 1999b)
(4) Critical habitat rule (68 FR 35950)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology On Oahu, *Silene lanceolata* grows on cliff faces and ledges of gullies in dry to mesic shrublands at elevations between 351 and 978 m (1,151 to 3,208 ft). Associated native plant species include *Artemisia australis*, *Bidens* sp., *Carex* sp., *Chamaesyce* sp., *Dodonaea viscosa*, *Lysimachia* sp., *Osteomeles anthyllidifolia*, *Schiedea mannii*, or *Tetramolopium filiforme*. Information on the reproductive cycles, longevity, specific environmental requirements, and limiting factors for this species are unknown (68 FR 35950).

Threats to the Species *Silene lanceolata* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Habitat destruction by feral goats, pigs, and sheep; fire from military activities; and competition with non-native plant species threaten *S. lanceolata* (U.S. Army Garrison 1999a; 68 FR 35950). Thus, although almost half of individuals (98 percent) are located outside the action area, *S. lanceolata* has a moderate background risk of species extinction range wide and high background risk of species extinction (because of low numbers of individuals) on Oahu without protection from existing and additional threats.

Conservation Needs of the Species   Conservation actions that should be implemented for the recovery of *Silene lanceolata* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). Conservation actions required for stabilization are described in the "Stabilization" section of the project description for this opinion. However, *S. lanceolata* is not included as a target taxon for stabilization under the Makua Implementation Plan Addendum. The Army does not actively manage this species on Oahu (Service 2003a).

The recovery plan for *Silene lanceolata* identifies several conservation actions that should be implemented for its recovery. Fenced exclosures should be constructed at all known occurrences to reduce impacts from ungulates. Subsequent control of ungulates and rats from all occupied sites will remove their impact on this species and its habitat. Control measures for non-native plant species that threaten *S. lanceolata* should be implemented. Augmentation of existing occurrences and the establishment of new occurrences should be done by outplanting when adequate propagated materials are available. Control of highly flammable vegetation and maintenance of fuelbreaks is also needed, for plant occurrences found growing in areas of high risk from fire.

Ongoing Conservation Actions   A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Silene lanceolata* (Hawaii and Pacific Plant Recovery Coordinating Committee 2007). This plan will include broader landscape actions that are needed for the recovery of this plant throughout its range. This species is also being propagated at Pahole Mid-Elevation Rare Plant Facility, Pohakuloa Training Area Plant Facility, and the Volcano Rare Plant Facility (Service 1999a; Service 2005b). In addition occurrences of this species occur in two management units where they may benefit from stabilization management of other species and/or ecosystem-level protection. The management units are Ohikilolo, which is fenced; and Waianae Kai Management Unit, which are not fenced.

Environmental Baseline of the Species

Status of the Species in the Action Area   Approximately 17 individuals, or less than two percent of the total known individuals of *Silene lanceolata,* occur within the Makua action area and are located within the Ohikilolo Management Unit in area of low fire risk.

Threats to the Species in the Action Area   The primary threats to *Silene lanceolata* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Silene lanceolata* is threatened by competition for light, space, and nutrients from non-native plant species; fires that result from Army training activities; and habitat degradation and destruction by feral goats and pigs (U.S. Army Garrison 1999a).

Conservation Needs of the Species in the Action Area   *Silene lanceolata* does not require stabilization pursuant to the guidelines established in the Makua Implementation Plan because only two percent of the known individuals occur within the action area. This species will, however, benefit from additional conservation actions such as fencing, ungulate and non-native plant control, and control of wildfires that are undertaken for other native plants in the action area (U.S. Army Garrison 1999a). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The Service is unaware of any species-specific management activities occurring in the action area for *Silene lanceolata*.

Status of the Critical Habitat – *Solanum sandwicense* (Popolo aiakeakua)

Critical Habitat Description A total of 2,975 ha (7,352 ac) of critical habitat was designated in five separate units on Kauai and Oahu for *Solanum sandwicense*. Two units were designated on Kauai and three units (328 ha; 811 ac) was designated on Oahu. To meet recovery goals, each unit is intended to provide habitat for one population, each represented by a minimum of 300 mature, reproducing individuals of *S. sandwicense*. Critical habitat has been designated on State lands on both islands (e.g., Kuia Natural Area Reserve, and Kokee and Na Pali Coast State Parks on Kauai, and Mokuleia Forest Reserve and Pahole Natural Area Reserve on Oahu) and private lands (Honouliuli Preserve) on Oahu (68 FR 9116; 68 FR 35950).

The primary constituent elements for the units on Oahu include talus slopes or streambeds at elevations between 471 and 1,006 m (1,545 and 3,300 ft), which occur in open, sunny areas that contain the associated native plant species *Pisonia* sp. and *Psychotria* sp. The plant community, associated species, and elevations are indicative of important features such as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to Critical Habitat The primary threats to critical habitat for this species on Oahu include habitat degradation by feral pigs, competition with non-native plant species, fire, and stochastic events such as landslides (68 FR 35950).

Environmental Baseline of the Critical Habitat

Status of the Critical Habitat in the Action Area Four percent (105 ha; 258 ac) of the State-wide critical habitat for *Solanum sandwicense* is located in one unit in the Makua action area. The critical habitat unit is located in the northeastern portion of the action area in the low fire risk area. This critical habitat unit provides habitat for the conservation of one population of *S. sandwicense*. It is estimated that nearly one-half of the critical habitat occurs in areas with greater than 75 percent native plant cover (K. Kawelo, pers. comm. 2004).

Threats to Critical Habitat in the Action Area Threats to primary constituent elements of the critical habitat in the action area include habitat degradation by feral pigs, competition from non-native plant species, and fire from military training activities (68 FR 35950).

Ongoing Conservation Actions Within the Action Area A total of 102 ha (253 ac), or 98 percent, of the critical habitat in the action area is in the Pahole, Upper Kapuna Sub-Unit and

Upper Kapuna Management Units. The Pahole Management Unit is fenced, and non-native plant species and ungulates within the unit are controlled. A fence for the Upper Kapuna Management Unit is planned for the near future (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Spermolepis hawaiiensis* (No Common Name)

Species Description *Spermolepis hawaiiensis*, a member of the Apiaceae (parsley) family, is a slender annual herb with few branches. Its leaves are dissected into narrow, lance-shaped divisions. *Spermolepis hawaiiensis* is the only member of the genus native to Hawaii. It is distinguished from other members of the family by being a non-succulent annual with an umbrella-shaped inflorescence (68 FR 35950).

Listing Status *Spermolepis hawaiiensis* was federally listed as endangered on November 10, 1994, and state listed as endangered in Hawaii at the same time. A recovery plan was prepared for this species in July 1999 (Multi Island Recovery Plan 1999; 59 FR 56333). Critical habitat was designated for this species on February 27, 2003 for the islands of Niihau and Kauai; March 18, 2003 for the island of Molokai; May 14, 2003 for the island of Kahoolawe and Maui; and June 17, 2003 for the island of Oahu (68 FR 9115; 68 FR 12981; 68 FR 25934; 68 FR 35950).

Historic and Current Distribution Historically, *Spermolepis hawaiiensis* was known from (Waimea) Kauai, (Koko Head) Oahu, (Paomai and Kahinahina) Lanai, and (Apua) Hawaii. Currently, a total of 12 occurrences of *S. hawaiiensis* are known on Kauai, Oahu, Molokai, Lanai, West Maui, and Hawaii. The total number of individuals State-wide is estimated between 5,000 and 10,000 individuals. On Kauai, this species has been observed in the Koaie branch and other unspecified locations within Waimea Canyon, Hanapepe at Kapahili Gulch, and Hipalau on State and private land. The total number of plants on Kauai is a few thousand. On Oahu, this species is known from a total of fewer than 60 individuals at Diamond Head and Makua-Keaau ridge on State and Federal lands, respectively. On Molokai, about 600 plants were reported from Kamalo, on private land. On Lanai, two occurrences of *S. hawaiiensis* are known: east of Puu Manu with 50 to 100 individuals and Kaa Gulch with about 300 individuals, both on private lands. On West Maui, *S. hawaiiensis* is known from two occurrences in the Lihau section of the West Maui Natural Area Reserve with 60 to 100 individuals and several hundred to thousands of plants, respectively; and, above Lahainaluna School with about 100 individuals. On the island of Hawaii, three occurrences of about 500 individuals are found on the U.S. Army's Pohakuloa Training Area in Kipuka Alala, Puu Anahulu, and an unnamed kipuka within the 1859 lava flow (Makua Implementation Team 2003) (Table SB 38).

Table SB 38. Range-wide Distribution of *Spermolepis hawaiiensis*.

Population Units	**Number of Known Individuals**					
	1991 (1)	**1999** (2)	**1999** (3)	**2003** (4)	**2005** (5)	**2006** (6)
Punapohaku	--	--	--	--	--	2/0
Ohikilolo	--	several hundred	<50 -several hundred	--	several hundred	170/184‡

Diamond Head	--	10-thousands	10-thousands	--	thousands	--
Total Population Units on Oahu	--	2	2	6	2	2
Total Individuals on Oahu	--	several hundred	<60–several hundred	110-910	thousands	(172/184)†
Total Population Units State-wide	6	12	12	6	9+	--
Total Individuals State-wide	thou-sands	2000-6000	5000 – 10,000	6,385-12,135*	thousands	--

Shaded occurrences are inside the action area.
*Taken from the USFWS list of Hawaiian Island Plants, August 11, 2003.
‡Total mature/immature individuals
†Total (mature/immature)

(1) Listing rule (56 FR55770)
(2) Recovery plan (Service 1999a)
(3) Makua Endangered Species Mitigation Plan (Service 1999b)
(4) Critical habitat rule (68 FR35950)
(5) Army re-initiation request (U.S. Army Garrison 2005c)
(6) Army database (U.S. Army Garrison 2006d)

Ecology *Spermolepis hawaiiensis* is known from various vegetation types, including *Metrosideros polymorpha* forests, *Dodonaea viscosa* lowland dry shrubland, cultivated fields, and pastures between about 300 and 600 m (1,000 and 2,000 ft) in elevation. Associated plant species include *Doryopteris* sp., *Gouania hillebrandii*, and *Sida fallax*. This species is an annual, and numbers fluctuate greatly from year to year, depending on climatic conditions and other unknown factors. Little else is known about the life history of this taxon. Reproductive cycles, specific environmental requirements, and limiting factors are unknown (Makua Implementation Team 2003).

Threats to the Species *Spermolepis hawaiiensis* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Current threats to *S. hawaiiensis* are habitat degradation by feral goats, axis deer, and mouflon sheep; competition with various non-native plants; wildfire; military activities; and destruction of habitat, as well as direct destruction of individual plants by erosion, landslides, and rockslides (Service 1999a; 68 FR 35950).

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Spermolepis hawaiiensis* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to the limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1999a). However, *S. hawaiiensis* is not included as a target taxon for stabilization pursuant to the Makua Implementation Plan Addendum. The Army does not actively manage this species in the Makua action area (Service 2003a).

The recovery plan for this species identifies the following important conservation actions. Fenced exclosures should be constructed around all known occurrences to reduce impacts from feral ungulates. Control of non-native plant species within the exclosures is also needed. Collection, storage, and propagation of representative genetic stock are needed, as well as augmentation of existing occurrences and establishment of additional occurrences (Service 1999a).

Ongoing Conservation Actions A State-wide strategic plan is being developed by the Hawaii and Pacific Plants Recovery Coordinating Committee that will address the long-term conservation of *Spermolepis hawaiiensis*. This plan will also include broader landscape actions that are needed for the recovery of this plant throughout its range. This species is being propagated at the Pohakuloa Training Area Rare Plant Facility. Currently, no other management actions are known for this species (Service 1999b; Service 2005b; Durand, pers. comm. 2004, Koob1996).

Critical Habitat Description A total of 578.6 ha (1,429.7 ac) in seven separate units on four islands has been designated as critical habitat for *Spermolepis hawaiiensis*. Two units were designated on Kauai (totaling 182 ha; 452 ac), two units were designated on Maui (totaling 114 ha; 280 ac), one unit was designated on Molokai (85 ha; 211 ac), and two units were designated on Oahu (totaling 137 ha; 339 ac). Critical habitat has been designated on State (e.g., Puu Ka Pele Forest Reserve and Waimea Canyon on Kauai; Kanaio and West Maui Natural Area Reserves on Maui; Diamond Head State Park on Oahu) and private lands. Each unit provides habitat for one population of 300, mature, reproductive individuals of *S. hawaiiensis* (68 FR 9116, 68 FR 25934, 68 FR 12982, 68 FR 35950). To meet recovery goals, a population should be represented by at least 300 mature, reproducing individuals of *S. hawaiiensis* (68 FR 35950).

The primary constituent elements of the units on Oahu include steep or vertical cliffs or the base of cliffs or ridges in coastal dry cliff vegetation containing one or more of the following associated native plant species: *Artemisia australis*, *Bidens* sp., *Dodonaea viscosa*, *Doryopteris* sp., *Heteropogon contortus*, *Santalum ellipticum*, or *Waltheria indica;* and elevations between 25 to 306 m (82 to 1,004 ft). The plant community, associated species, and elevations are a barometer for such things as soil moisture, nutrient cycling and availability, temperature ranges, and light levels, which are included as primary constituent elements of the habitat required for the conservation of this species (68 FR 35950).

Threats to the Critical Habitat The primary threats to critical habitat for this species on Oahu include habitat degradation by feral ungulates; non-native plant species; and habitat degradation or destruction from erosion, landslides, and wildland fire (68 FR 35950). See the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Currently, fewer than 356 individuals, approximately three to seven percent, of the estimated 5,000 to 10,000 individuals of *Spermolepis hawaiiensis,* are found within the Makua action area (Service 1999a, Makua Implementation Team 2003,U.S. Army Garrison; 2005c, 2006d). Two occurrences of *S. hawaiiensis* are found in the action area in the Punapohaku and Ohikilolo Management Units. Both occurrences are at risk from training-related wildfire and are within the high fire risk zone, which includes 356 individuals (172 mature plants and 184 seedlings). Thus, *S. hawaiiensis* in the action area is characterized by one stabilization population unit exceeding minimum numerical criteria comprising roughly 10 percent of all remaining individuals on Oahu and three to seven percent of the State-wide individuals, with numbers that have increased slowly due to discovery of new individuals. All individuals are within high risk fire zones (Service 2005b).

<u>Status of the Critical Habitat in the Action Area</u> There is one critical habitat unit within the Makua action area, comprising four percent, 21 ha (53 ac), of the total State-wide critical habitat for *Spermolepis hawaiiensis*. The critical habitat unit is located in the southwestern portion of the action area in the Lower Ohikilolo Management Unit. This habitat unit was designated to provide a portion of the habitat for the conservation of one population with a minimum of 300 mature, reproducing individuals of *S. hawaiiensis* (68 FR 35950). Approximately 1 ha (2 ac) is in the high fire risk zone and the remaining portion in the low fire risk zone. The constituent elements essential for this species include, but are not limited to, steep or vertical cliffs or the base of cliffs or ridges in coastal dry cliff vegetation. The primary constituent elements that may be affected by a training related fire include those associated native plant species found within coastal dry cliff vegetation. It is estimated that the entire critical habitat is within an area of vegetation that is predominantly non-native (K. Kawelo, pers. comm. 2004; Service 2004). This indicates that this critical habitat unit is degraded due to non-native plant encroachment.

<u>Threats to the Species and Critical Habitat in the Action Area</u> The primary threats to *Spermolepis hawaiiensis* and its critical habitat in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. The primary threats to *S. hawaiiensis* and its critical habitat include destruction of habitat and direct destruction of *S. hawaiiensis* plants due to; habitat degradation by feral ungulates; competition for light, space, and nutrients from non-native plant species; and wildfire from military activities. In addition, critical habitat is threatened by predation of associated native plants by rats, slugs, the black twig borer, and the Chinese rose beetle (Makua Implementation Team 2003; 68 FR 35950).

<u>Conservation Needs of the Species and Critical Habitat in the Action Area</u> *Spermolepis hawaiiensis* will not be stabilized pursuant to the guidelines established in the Makua Implementation Plan because the individuals in the Makua action area represent less than one percent of the known individuals of this species. However, this species will benefit from ecosystem-level management within the action area that includes activities such as fencing, ungulate removal, and reduction of non-native plant species and control of wildfires (Makua Implementation Team 2003, U.S. Army Garrison 2004a, 2005b, 2006c). A post-fire revegetation plan and a site-specific fire management plan has been developed for the lower Ohikilolo Management Unit (U.S. Army Garrison2003a). Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

<u>Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area</u> At this time, the Service is unaware of any specific species management activities occurring in the action area for *Spermolepis hawaiiensis*. Approximately four percent, 21 ha (53 ac), of the critical habitat occurs within the action area The Army controls non-native plants to reduce

competition with associated plant species and to reduce the risk of fire within the Ohikilolo Management Unit that contains a portion of this critical habitat (K. Kawelo, pers. comm. 2004).

Status of the Species and Critical Habitat – *Tetramolopium filiforme* (No Common Name)

Species Description *Tetramolopium filiforme* is a short-lived perennial of the Asteraceae (sunflower) family. It is a dwarf shrub 5 to 15 cm (2 to 6 in) tall, often mounded in shape. The narrow leaves are 1 to 2 cm (0.4 to 0.8 in) long and are clustered at the branch tips. The purple-white flower heads are held above the foliage on long slender stalks. The white to pale lavender ray florets are female, and the maroon or (rarely) yellow disk florets are functionally male. The achenes (a type of dry, closed fruit) are 2 to 2.7 mm (about 0.1 in) long, tipped with bristles almost as long as the achenes, and may have sparse, short glandular hairs (Wagner et al 1999; Makua Implementation Team 2003).

There are two varieties of *Tetramolopium filiforme*, which are differentiated primarily by leaf shape and leaf margin. Variety *filiforme* has extremely narrow, linear leaves with no teeth along the leaf margins; var. *polyphyllum* has leaves that widen towards the leaf apex, with prominent teeth along the leaf margins. These two morphological types are not clearly separated geographically, and their taxonomy needs clarification (Makua Implementation Team 2003). Occurrences along the higher part of Ohikilolo Ridge may contain either of the two varieties, as well as plants with intermediate characteristics. In general, Hawaiian *Tetramolopium* species are highly inter-fertile and appear to be maintained as separate entities through either geographical or ecological separation (Makua Implementation Team 2003).

Listing Status *Tetramolopium filiforme* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). Both varieties of *T. filiforme* are included in the listed taxon.

Historic and Current Distribution *Tetramolopium filiforme* is narrowly endemic to the northern leeward Waianae Mountains of Oahu, with its center of abundance on Ohikilolo Ridge in Makua (Makua Implementation Team 2003). Historically, this species was known from Ohikilolo Ridge, Keaau Valley, and Makaha Valley (56 FR 55770). Currently, it is found only in small outlying population units from Kahanahaiki in the north to Kamaileunu Ridge and Puhawai in the south. Only on Ohikilolo Ridge do both varieties occur. Plants on the low, dry, seaward end of the ridge are all typical var. *filiforme*. With ascending elevation into more mesic habitats, plants with var. *polyphyllum* traits begin to appear together with plants of var. *filiforme*. At the highest part of the ridge, most plants show var. *polyphyllum* traits to some degree, and this variety is found only at the higher, wetter part of the ridge. Nowhere along the ridge, however, do all the plants represent var. *polyphyllum*. All known plants occurring outside Ohikilolo Ridge represent var. *filiforme* (Makua Implementation Team 2003). Trends in distribution indicate the number of plants on Ohikilolo Ridge has declined significantly over the last few decades owing to damage by feral goats. In the 1970s, many plants occurred along the crest of the ridge; however, because of a proliferation of goats on the ridge in the 1980s and 1990s, *T. filiforme* is no longer abundant on the accessible parts of the ridge top. This species still persists in relatively large numbers on cliff faces inaccessible to goats (Makua Implementation Team 2003).

Currently, *Tetramolopium filiforme* occurs in seven population units totaling approximately 3,500 individuals (Table SB 39). These population units are found on Federal and State lands (68 FR 35950). Three of the existing population units have exceeded minimum criteria for stabilization population (at least 50 mature, reproducing individuals for short-lived perennials). Trends in numbers since listing indicate increases until 2003 and decreasing numbers since then in all population units except Keaau and Waianae Kai. In 2003, the last plant in the Waianae Kai population unit was reported as dead (Makua Implementation Team 2003). By 2004, a new population had appeared there, presumably from viable seeds in the soil seed bank (U.S. Army Garrison 2004a). Plants in the Kahanahaiki, Keaau, Makaha/Ohikilolo Ridge, and Ohikilolo population units are located in zones at risk from training-related wildfire. Thus, *T. filiforme* is characterized by seven population units and an overall decreasing trend in numbers since 2003, including three stabilization population units with relatively large numbers that are located in all fire risk zones.

Table SB 39. Range-wide Distribution of *Tetramolopium filiforme.*

<table>
<tr><th rowspan="2">Population Units</th><th colspan="6">Number of Known Individuals</th></tr>
<tr><th>1991
(1)</th><th>1995-1998
(2)</th><th>2003
(3)</th><th>2004
(4)</th><th>2005
(5)</th><th>2006
(6)</th></tr>
<tr><td>Kahanahaiki</td><td>--</td><td>--</td><td>50</td><td>34/0</td><td>45/0</td><td>45/0</td></tr>
<tr><td>Keaau</td><td>--</td><td>--</td><td>25</td><td>16/4</td><td>16/4</td><td>30/58</td></tr>
<tr><td>Kaiena*</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>9/0</td></tr>
<tr><td>Makaha/ Ohikilolo Ridge*¶</td><td>--</td><td>--</td><td rowspan="2">2500</td><td rowspan="2">2500</td><td>200/0</td><td>200/0</td></tr>
<tr><td>Ohikilolo Mauka*</td><td>--</td><td>--</td><td rowspan="2">2445/552</td><td rowspan="2">2442/553</td></tr>
<tr><td>Ohikilolo Makai*</td><td>--</td><td>--</td><td>2500</td><td>2500</td></tr>
<tr><td>Makaha/ Ohikilolo Ridge*¶</td><td>--</td><td>--</td><td>--</td><td>--</td><td>100/0</td><td>100/0</td></tr>
<tr><td>Puhawai*</td><td>--</td><td>--</td><td>6/6‡</td><td>2/0</td><td>2/11</td><td>1/5
[18/0]§</td></tr>
<tr><td>Waianae Kai*</td><td>--</td><td>--</td><td>0</td><td>20/2</td><td>30/9</td><td>30/9</td></tr>
<tr><td>Total Individuals</td><td>500</td><td>1500-1550</td><td>5087
(5081/6)†</td><td>5078
(5072/6)</td><td>3414
(2838/576)</td><td>3500
(2857/625)
[18/0]§</td></tr>
</table>

Shaded population units are inside the action area.
*Stabilization population units
¶ Makaha/Ohikilolo Ridge population unit is partially within the action area.
‡Total mature/immature individuals
†Total (mature/immature)
§[augmented and or reintroduced]

(1) Listing rule (61 FR 53108)
(2) Recovery plan (Service 1998a)
(3) MIP (MIT 2003), Oahu Biological Opinion (Service 2003a)
(4) MIP Addendum and 2004 status update (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)

(5) Critical habitat rule (68 FR 35950)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Tetramolopium filiforme* occurs in dry habitat at the seaward end of the Ohikilolo population unit and in dry-mesic and mesic habitats at higher, more inland locations. In general, the plants are found on exposed rocky ridges and sparsely vegetated, nearly vertical cliffs, often rooted in cracks in the rock, at elevations of 340 to 900 m (1,116 to 2,953 ft) (Makua Implementation Team 2003). Flowering usually occurs in the late winter and spring. Although capable of self-pollination, *T. filiforme* probably is insect-pollinated, as are most species in the sunflower family with conspicuous flowers. The seeds of *T. filiforme* are presumed to be wind-dispersed, as bristle-bearing achenes also are characteristic of wind-dispersed members of the sunflower family. Birds may also disperse the seeds because the bristles may adhere the achenes to their feathers (Makua Implementation Team 2003). This species is relatively short-lived, usually less than five years. Other demographic information for *T. filiforme* in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Tetramolopium filiforme* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. In particular, *T. filiforme* is one of the Makua target taxa most threatened by fire. Over the last 20 years, fires have burned into the lower reaches of the Ohikilolo population unit and have almost reached the Kahanahaiki population unit. In addition, infestations of at least two species of non-native scale insects have been observed on *T. filiforme* and need further research (Makua Implementation Plan 2003). Thus, despite its overall relative abundance, *T. filiforme* has a high background risk of species extinction due to its occurrence in high fire risk zones, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Tetramolopium filiforme* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve management of stabilization populations and abatements to threats (Service 1995a, 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization protocols for *Tetramolopium filiforme*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, this species occurs in two management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Puu Kumakalii, which is not fenced and for which no fence construction is planned, and Ohikilolo, which is fenced.

Tetramolopium filiforme seeds store well for several years, but viability is poor. The Army is focusing on collecting seed from fire-threatened sites in the lower Ohikilolo population unit. Plants can be propagated from both seed and cuttings. Cuttings are more than 90 percent successful, and The Nature Conservancy of Hawaii has successfully propagated the related *T. lepidotum* from seed. Outplanting has yet been attempted for *T. filiforme* in the wild because this species commonly grows in shallow cracks on exposed rocky ledges and cliffs; transitioning greenhouse plants to such sites may be difficult (U.S. Army Garrison 2005b). Current *ex situ* collections for this species include 31,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Environmental Baseline of the Species

Status of the Species in the Action Area About 96 percent of all known individuals of *Tetramolopium filiforme* are located within the action area, in the Kahanahaiki, Keaau, Makaha/Ohikilolo Ridge, and Ohikilolo population units (see Table SB 39). No critical habitat for this species is located within the action area. Two population units within the action area (Makaha/Ohikilolo Ridge and Ohikilolo) have exceeded minimum criteria for a stabilization population (defined as at least 50 mature, reproducing individuals). However, threats are not controlled and genetic storage goals are not complete, so these population units are not met all criteria for a stabilization population. Overall numbers in the action area have declined since 2003, from 5,087 to 3,500 total individuals in 2006.

The Ohikilolo population unit is the center of abundance for *Tetramolopium filiforme* and is the numerically the most significant unit. Army Natural Resources Staff split Ohikilolo occurrences into two population units to demonstrate management differences between the Makua and Makaha sides of the ridge (U.S. Army Garrison 2005b). The Ohikilolo population unit is on the Makua side of the fence along the installation boundary, and the Makaha/Oikikilolo Ridge population unit is outside of it. The Ohikilolo population unit is located within the Ohikilolo Management Unit, along the steep south wall of Makua valley. Vegetation consists of native dry cliff communities, ridgetop mesic native shrubland dominated in some areas by *Dodonaea* and *Metrosideros* species, and areas of *Pritchardia kaalae* lowland mesic forest, a rare natural community (U.S. Army Garrison 2005a). The Keaau population unit is located near the Ohikilolo population unit but outside the installation's south boundary. The Kahanahaiki population unit is located in the C ridge vicinity of Makua, outside the Kahanahaiki Management Unit. *Tetramolopium filiforme* plants are located on a small, sparsely vegetated cliff surrounded by *Diospyros sandwicensis* forest. The Kahanahaiki population unit is not fenced, but ungulates are not a threat, as goats have been virtually eliminated from the installation. Approximately 50 percent of the known individuals of *T. filiforme* are protected from ungulates by fencing.

All *Tetramolopium filiforme* plants in action area population units are located in areas at risk from training-related wildfire. About 1,045 individuals (30 percent of known individuals) occur in the high fire risk zone; the remainder occurs in the low and very fire risk zones. However, most of the plants in the Ohikilolo population unit are located on the ridge farther back in the valley in an area that is not continuous with the dense fuels of the lower valley. In the seaward part of this population unit, most of the plants are located on steep cliffs lacking dense fuel vegetation and probably would not be burned (U.S. Army Garrison 2005b). Plants in the Kahanahaiki population unit, however, are extremely vulnerable to fire. The July 2003 prescribed fire burned at least 2 ha (5 ac) of native forest within 20 m (66 ft) of this site, which is now buffered by only a small strip of forest and could be extirpated by future fires (U.S. Army Garrison 2003b, 2005b). Thus, *T. filiforme* in the action area is characterized by four population units located within high to low to very low fire risk zones, including three population units meeting minimum numerical criteria for stabilization with relatively high but decreasing numbers.

Threats to the Species in the Action Area The primary threats to *Tetramolopium filiforme* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. *Tetramolopium filiforme* in the action area, and especially within the installation boundary, is extremely vulnerable to wildfire from military training activities. Fire has severely degraded habitat in the Ohikilolo and Kahanahaiki population units (U.S. Army Garrison 2005b). Thus, because 96 percent of all known individuals occur within the action area in zones of high to very low fire risk, *T. filiforme* in the action area has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Tetramolopium filiforme* because there are no stabilization population units outside the action area, threats are not fully controlled, and genetic storage is not complete. Three population units have been identified for stabilization of *T. filiforme*: Ohikilolo within the action area, and Puhawai and Waianae Kai outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals are located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced (fence construction for this area is planned for 2011). The Keaau and Makaha/Ohikilolo Ridge population units are not fenced, and goats are a problem in both areas. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The action area contains 96 percent of the total remaining individuals of *Tetramolopium filiforme*. The Ohikilolo stabilization population unit, which contains 86 percent of the total remaining individuals, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). This population unit is located within the Ohikilolo Management Unit. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, and goats have been virtually eradicated from Makua. Genetic storage goals for *T. filiforme* are 25 percent complete, with 75 plants from all six population units combined meeting the goals of the Makua Implementation Plan, and there are currently four plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species and Critical Habitat – *Viola chamissoniana* ssp. *chammissoniana* (Pamakani)

Species Description *Viola chamissoniana* ssp. *chamissoniana* is a short-lived perennial of the Violaceae (violet) family. It is a basal-branching woody shrub with branches 20 to 60 cm (8 to 23 in) long. Some occurrences, especially on steep cliffs, have plants with reclining or drooping branches; plants in other occurrences have erect branches forming upright shrubs. The triangular leaves are 2 to 4 cm (0.8 to 1.6 in) long and clustered at the ends of the stems. The flowers are large, white, and held above the leaves. The tiny, dark, egg-shaped seeds are borne in capsules that open as they dry (Wagner et al 1999; Makua Implementation Team 2003).

There are three subspecies of *Viola chamissoniana*: ssp. *chamissoniana* (Oahu), ssp. *tracheliifolia* (Kauai, Oahu, Molokai, and Maui), and ssp. *robusta* (Molokai). The subspecies *tracheliifolia* and *robusta* are not considered rare. The only other native *Viola* occurring in the Waianae Mountains of Oahu is the common *V. chamissoniana* ssp. *tracheliifolia*, which like ssp. *chamissoniana*, occurs throughout that mountain range. Subspecies *tracheliifolia* is generally found growing in the forest understory, whereas ssp. *chamissoniana* is most often in open, exposed habitats. Several sites are known where the two subspecies grow side by side, without natural hybridization.

<u>Listing Status</u> *Viola chamissoniana* ssp. *chamissoniana* was federally listed as endangered on October 29, 1991 (56 FR 55770), and was State listed as endangered at the same time. This species is included in recovery plans for Waianae plants (Service 1995a) and Oahu plants (Service 1998a). Critical habitat for the listed taxon was designated on June 17, 2003 (68 FR 35950). Only the subspecies *chamissoniana* is listed as the endangered taxon.

<u>Historic and Current Distribution</u> *Viola chamissoniana* ssp. *chamissoniana* is a species endemic to the Hawaiian Islands. *Viola chamissoniana* ssp. *chamissoniana* is endemic to the island of Oahu and is known only from the Waianae Mountains. It has been recorded throughout the mountain range on both the windward and leeward sides. Demographic data for this species is deficient, and apparent increases in the number of population units probably reflect more consistent survey efforts since the species was listed, and because all known occurrences were discovered only within the last 20 years. Many *V. chamissoniana* ssp. *chamissoniana* plants grow on steep cliffs inaccessible to feral ungulates, so this taxon may not have declined as much as other taxa that are not cliff-dwelling. *Viola chamissoniana* ssp. *chamissoniana* also may once have been more common on gentler slopes and has persisted only on steep cliffs inaccessible to feral ungulates (Makua Implementation Team 2003).

Currently, *Viola chamissoniana* ssp. *chamissoniana* occurs in eight population units totaling approximately 618 individuals (Table SB 40). These population units are found on Federal and State lands (68 FR 35950). One of these population units has exceeded minimum numerical criteria for a stabilization (defined as at least 50 mature, reproducing individuals for short-lived perennials). Data on numbers of individuals has only been consistent with monitoring since 2003 and indicate an increase from 374 to 618 total known individuals. This increase includes some additional individuals recently discovered in the Puu Kamakalii population unit. The Keaau and Ohikilolo population units are located in the Makua action area, and the Puu Kamakalii population is located in the action area of Schofield Barracks Military Reservation. These occurrences are located in zones at risk from training-related wildfire. Thus, *V. chamissoniana* ssp. *chamissoniana* is characterized by eight population units with low numbers, except for one population unit that exceeds minimum criteria for stabilization.

Table SB 40. Range-wide Distribution of *Viola chamissoniana* ssp. *chammissoniana*.

Population Units	**Number of Known Individuals**					
	1991 (1)	**1995-1998** (2)	**2003** (3)	**2004** (4)	**2005** (5)	**2006** (6)
Keaau	--	--	--	40/10	40/10	40/10
Makaha/Ohikilolo Ridge*	--	--	250/0‡	250/0	12/0	7/0
Ohikilolo*					377/2	433/10
Halona	--	--	3	32/3	32/3	41/3
Kamaileunu	--	--	38	38/0	35/0	35/0
Makaha*	--	--	50	50/0	24/2	24/2
Makaha/Ohikilolo Ridge*	--	--	--	--	20/0	--
Puu Hapapa	--	--	10/3	10/0	10/6	13/0
Puu Kamakalii (SBMR) *	--	--	19/1	53/0	44/0	--
Total Individuals	**14**	**237-257**	**374**	**486** (473/13)†	**617** (594/23)	**618** (593/25)

Shaded population units are inside the action area.
‡Total mature/immature individuals
*Stabilization population units
†Total (mature/immature)
SBMR = Schofield Barracks Military Reservation

(1) Listing rule (56 FR 55770)
(2) Recovery plans (Service 1995a, 1998a)
(3) Makua Implementation Plan (Makua Implementation Team 2003)
(4) MIP Addendum and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status report (U.S. Army Garrison 2005b), K. Kawelo (pers. comm., 2005)
(6) 2006 status update (U.S. Army Garrison 2006c)

Ecology *Viola chamissoniana* ssp. *chamissoniana* occurs in mesic habitats at elevations of 700 to 1,000 m (2,297 to 3,281 ft). It is usually found on north-facing cliffs and cliff ledges that are sparsely to moderately vegetated with native shrubs, grasses, and sedges. Such sites are among the most native and undisturbed mesic habitats of the Waianae Mountains. This taxon also is found on gentle slopes in native shrubland (Makua Implementation Team 2003). Little is known about the breeding system of *V. chamissoniana* ssp. *chamissoniana*. The large, white, fragrant flowers held above the leaves suggest pollination by moths. Plant longevity probably is similar to that of other small shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for *V. chamissoniana* ssp. *chamissoniana* in the wild is uncertain, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements.

Threats to the Species *Viola chamissoniana* ssp. *chamissoniana* was listed as endangered because of major ecosystem-level threats to its survival and recovery, which are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Because of its overall relative abundance and population units in fire risk zones, *V. chamissoniana* ssp. *chamissoniana* has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species Conservation actions that should be implemented for the recovery of *Viola chamissoniana* ssp. *chamissoniana* are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve utilizing stabilization populations to aid in recovery (Service 1995a, 1998a).

Ongoing Conservation Actions The Makua Implementation Team (2003) has developed stabilization criteria for *Viola chamissoniana* ssp. *chamissoniana*, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, this species occurs in four management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Makaha, Palikea, and Puu Kumakalii, which are not fenced, and Ohikilolo, which is fenced.

Viola chamissoniana ssp. *chamissoniana* is easy to propagate from seeds and cuttings. Seeds can be stored at appropriate conditions for several years with 60 percent germination success, and cuttings are also about 60 percent successful. Seed is difficult to collect because wild plants produce very few flowers and seeds at a time. Flowering of some greenhouse plants is more prolific, but most of the fruits are aborted. The Army is conducting nursery pollination experiments to determine limiting factors to seed production (U.S. Army Garrison 2005b). Current *ex situ* collections for this species include 31,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b).

Environmental Baseline of the Species

Status of the Species in the Action Area Approximately 81 percent of all known individuals of *Viola chamissoniana* ssp. *chamissoniana* are located within the action area, in the Keaau, Makaha/Ohikilolo Ridge, and Ohikilolo population units (see table above). No critical habitat for this species is located within the action area. One population unit (Ohikilolo) has met minimum criteria for stabilization (at least 50 mature, reproducing individuals). However, threats are not controlled and genetic storage goals are not complete, so this population unit is not considered meeting overall criteria for stabilization (U.S. Army Garrison 2005b). Overall numbers in the action area have increased since 2003, from 250 to approximately 500 total individuals. This increase includes an additional sub-population recently discovered in the Makaha/Ohikilolo Ridge population unit (U.S. Army Garrison 2005b). All plants in the action are located in areas at risk from training-related wildfire; however, all individuals of *V. chamissoniana* ssp. *chamissoniana* are located in the very low fire risk zone. These individuals at risk from fire in the action area represent about 81 percent of the species' total range-wide numbers.

Army Natural Resources Staff split Ohikilolo occurrences into two population units to demonstrate management differences between the Makua and Makaha sides of the ridge (U.S.

Army Garrison 2005b). The Ohikilolo population unit is on the Makua side of the fence along the installation boundary, and the Makaha/Oikikilolo Ridge population unit is outside of it. The Ohikilolo population unit is located within the Ohikilolo Management Unit, along the steep, south wall of Makua valley. Vegetation consists of native, dry cliff communities, ridgetop mesic native shrubland dominated in some areas by *Dodonaea* and *Metrosideros* species, and areas of *Pritchardia kaalae* lowland mesic forest, a rare natural community (U.S. Army Garrison 2005a). The Keaau population unit is located near the Ohikilolo population unit but outside the installation's south boundary. Thus, *V. chamissoniana* ssp. *chamissoniana* in the action area is characterized by three population units located within high to very low fire risk zones, including one population unit that exceeds minimum number of individuals suggested in the recovery plans for Waianae plants and Oahu plants for stabilization populations.

Threats to the Species in the Action Area The primary threats to *Viola chamissoniana* ssp. *chamissoniana* in the action area are those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section and tabulated in Appendix E. Because about 81 percent of all known individuals occur within the action area in the very low fire risk zones, *V. chamissoniana* ssp. *chamissoniana* in the action area has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence.

Conservation Needs of the Species in the Action Area The Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) includes *Viola chamissoniana* ssp. *chamissoniana* because more than 80 percent of remaining individuals are located within the action area and there is only one population unit that has met criteria for stabilization outside the action area. In addition, threats are not fully controlled and genetic storage is not complete. Three population units are identified for stabilization of *V. chamissoniana* ssp. *chamissoniana*: Ohikilolo within the action area, and Puu Kumakalii and Makaha outside the action area. Post-fire revegetation plans and site-specific fuels modification are needed where individuals are located in the action area. About 15 ha (38 ac) of the Ohikilolo Management Unit is not fenced; fence construction for this area is planned for 2011. Fence construction is planned for the Makaha Management Unit in 2007 thru 2009. Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section.

Ongoing Conservation Actions for the Species in the Action Area The three population units in the action area contain 81 percent of the total remaining individuals of *Viola chamissoniana* ssp. *chamissoniana*. The population unit inside the action area, which contains 72 percent of the total remaining individuals, is being managed for stabilization as specified by the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005b). The Ohikilolo population unit is located within the Ohikilolo Management Unit. A major part of the Ohikilolo Management Unit is protected by a boundary ridgeline fence, and goats have been virtually eradicated from Makua. Genetic storage goals for *V. chamissoniana* ssp. *chamissoniana* are over two percent complete, with 10 plants from all eight population units combined meeting the goals of the Makua Implementation Plan. There are currently 37 plants growing in the Army nursery (U.S. Army Garrison 2005b).

Status of the Species – *Achatinella mustelina* tree snails (Oahu Tree Snails)

Species Description   Adult *Achatinella mustelina* snails have oblong to ovate shells 19 to 24 mm (0.75 to 0.94 in) in length and with a glossy to semi-glossy surface. The shell may coil either to the left (sinistral) or to the right (dextral) and has between five to seven whorls. The umbilicus (the space along the axis of coiling) is closed. The lip at the opening of the adult shell is smooth and simple with no ribs, ridges, or folds, and become thickened and flares outward at maturity. The columella (the internal shell material around the axis of coiling) has a well developed spiral lamella (ridge). The shells of *A. mustelina* have a range of colors and patterns that vary with location along the Waianae mountain range. In the vicinity of the Makua Valley, the shells are most often colored brown with a single spiral white band (Pilsbry and Cooke 1912-1914).

Listing Status   All 41 species of Oahu tree snails were listed on January 13, 1981, as endangered under the single genus name *Achatinella* (46 FR 3178) and simultaneously listed under the State of Hawaii Endangered Species Act (HRS 195D-4a). A recovery plan covering all 41 snail species was prepared in 1993 (Service 1993). Critical habitat has not been designated for these snails. The Oahu Tree Snail Recovery Plan maps four essential habitat areas in the Waianae and Koolau Mountains (north and south in each range).

Historic and Current Distribution   Before human settlement of the Hawaiian Islands, dry, mesic, and wet forests covered approximately 127,000 ha (approximately 314,000 ac) on Oahu (HINHP 1991). It is likely that the *Achatinella* tree snails occupied all but the driest of these forest environments. This view is supported by the known historic and current distributions of these snails. Historically, tree snails were reported at elevations as low as 300 m (1,000 ft) and this lower limit was set by the clearing of forests for agriculture and cattle pastures (Pilsbry and Cooke 1912-1914). Sub-fossil shell collections show that snails occurred almost to the shore on the windward coast of Oahu. Information on the historic distribution of *A. mustelina* showed that this tree snail flourished in mesic forests in the Waianae Mountains of Oahu (Pilsbry and Cooke 1912-1914). Shells found at lower and dryer locations in the Waianae Mountains indicate that this snail species can tolerate moderately dry conditions.

Hadfield (1986) reviewed the literature on the historic abundance of Hawaiian tree snails and reports that Hawaiian tree snails were generally very abundant in many forested areas. Shell collectors often spoke of hundreds or thousands of snails in each collecting lot, and they would often collect from horse back as they rode through the forests of the Koolau and Waianae Mountains. There are several reports indicating that hundreds to thousands of snails could be collected in a single afternoon. In Nuuanu Valley, Cooke (1903) reported collecting 3,000 *Achatinella bellula* from an area 91 by 366 m (300 ft by 1,200 ft) and at an elevation of 300 to 427 m (984 to 1,401 ft). In Palolo Valley, snails of *A. viridans* were so dense that they "...hung in clusters on the hoe vines". Based on these types of historic records, we can conclude that many *Achatinella* tree snails were very abundant prior to impacts from humans. The population trend for all Oahu tree snails is an overall decline in numbers of individuals within an occurrence and a decline in the number of occurrences throughout the range of the species. This has resulted in a significant reduction in the occupied range of each species, which was probably already substantially reduced for some species by the early 1900s (Pilsbry and Cooke 1912-1914).

Current assessment of the status and current trends of *Achatinella mustelina* is somewhat tentative, due to the continuing loss of individuals, mostly from predation by non-native rats and snails. Information on the numbers of remaining populations is more reliable. Data used to assess the current status of these snails was obtained from the most current records from the Army (K. Kawelo, pers. comm. 2007). The detailed status and location information for these data will be presented in the environmental baseline.

Achatinella mustelina was historically known from middle to upper elevation locations throughout the northern and southern Waianae Mountains. Currently, *A. mustelina* is the most abundant of the Oahu tree snails, and is known from 120 point occurrences representing approximately 94 populations. Qualitative estimates from counts of snails during day visits indicate that there are approximately 2,000 Oahu trees snails in the wild. Seventeen (18 percent) of the populations are within the Makua action area (see Environmental Baseline for status and location information). Seventy-seven (82 percent) of the populations (approximately 72 percent of the known individuals) are outside of the Makua action area. Based on information from the Army (K. Kawelo, pers. comm. 2007), snails are known from to following general areas (listed in geographic proximity to one another, from north to south):

Kahanahaiki (4 occurrences)
Pahole Gulch (2 occurrences)
Kapuna-Makua ridge (3 occurrences)
South Makua ridge (8 occurrences)
West Makaleha (6 occurrence)
East Makaleha (12 occurrence)
Upper Kaala NAR (4 occurrence)
Lower Kaala NAR (9 occurrences)
Makaha-Waianae Kai ridge (13 occurrences)
Schofield Barracks (4 occurrences)
Puu Kalena (10 occurrences)
Puu Kumakalii (5 occurrences)
Puu Hapapa (11 occurrences)
Puu Kanehoa (5 occurrences)
Puukaua (8 occurrences)
north of Puu Palikea (5 occurrences)
Puu Palikea (10 occurrences)
Mauna Kapu (1 occurrence).

Thirty-seven (39 percent) of the populations have only a single recorded count of the numbers of snails in the population. No data is available for eight populations. Among the remaining populations, 20 appear to be stable, 6 appear to be increasing, and 23 appear to be decreasing. Based on these values, approximately 48 percent of the known populations are probably in decline, 40 percent appear to be stable, and 12 percent may be increasing.

<u>Ecology</u> *Achatinella* tree snails are arboreal and feed on fungus and algae that grown on the surface of leaves of native plants (Pilsbry and Cooke 1912-1914; Hadfield and Miller 1989). The snails are most often found in mesic and wet forests above about 366 m (1,200 ft) elevation in the Waianae and Koolau Mountains but are not found above about 1,158 m (3,800 ft)

elevation on Mount Kaala, the highest point on Oahu. They are occasionally seen on alien vegetation, but rarely establish populations on non-native plants and usually avoid native trees and shrubs with pubescent leaves (Service 1993; Pilsbry and Cooke 1912-1914). Snails seal themselves to leaves or stems during the day, and at night they move about freely. Movement is limited, and marked snails have been observed in the same bush or tree for years at a time (Service 1993; Hadfield and Miller 1989; Hadfield et al 1993; Kobayashi and Hadfield 1996). Dispersal appears to be mostly due to occasional storms or high winds that blow snails out of the trees. Subsequently, the snails will crawl on the ground until they encounter vegetation that allows them to get back up into a host tree. Following periods of high winds, marked snails have been observed to be dispersed as much 18 m (60 ft) from where they were last seen (Hadfield, pers. comm. 1986).

Tree snails become sexually mature in three to five years, and they may live for 15 to 20 years. Sexual maturity is marked by a termination of shell growth and a thickening of the growth margin of the shell. All members of the genus are hermaphroditic, and a species of the sister genus *Partulina* is known to be capable of self-fertilization (Kobayashi and Hadfield 1996), this may also apply to some of the *Achatinella* species. Reproductive output is low with an adult snail giving birth to 4 to 6 live young per year. Each new born snail is between 3.5 to 5 mm (0.14 to 0.20 in) long at birth (Service 1993; Hadfield and Miller 1989; Hadfield et al 1993; Kobayashi and Hadfield 1996).

The genetic structure of *Achatinella mustelina* was recently investigated by Holland and Hadfield (2002), and Holland (2007). Gene sequence analyses of cytochrome oxidase I of *A. mustelina* has been done using snails from multiple tree snail occurrences that cover the full species range in the Waianae Mountains. The results show two main features: previously described subspecies are not supported by the genetic analyses and the subspecies should be synonymized (Holland and Hadfield 2007); and population genetic structure is strongly correlated with topographic features (Holland and Hadfield 2002). Maximum genetic distances were independent of geographic distances, and instead were influenced by deep valleys or steep mountain peaks. Six evolutionarily significant units (ESUs) were identified in this study, and two additional tree snail occurrences were included to cover the full range of the two largest ESUs.

<u>Threats</u> Rats and predatory snails (*Euglandina rosea*) are known to occur throughout the Waianae Mountains and are major causes of decline and extinction of tree snail populations (Hadfield and Mountain 1980; Hadfield 1986; Hadfield and Miller 1989; Hadfield et al 1993). The Recovery Plan for the Oahu Tree Snails (Service 1993) reviews documented declines in tree snail occurrences associated with predation by non-native snails and rats. Other alien species that may prey upon Oahu tree snails include two terrestrial flatworms (*Geoplana septemlineata* and *Platydemis manokwari*) and a small terrestrial snail *Oxychilus alliarius*. *Platydemis manokwari* is a documented major predator on tree snails from other Pacific Islands and is known to occur on Oahu. *Geoplana septemlineata* and *Oxychilus alliarius* are regularly found feeding on the tissues of dead Oahu tree snails, but it is not known if these two animals were the cause of death.

Habitat disturbance and destruction also threaten Oahu tree snails, including *Achtinella mustelina*. Rooting by pigs, browsing by goats, and hiking, hunting, camping or similar activities can disturb native habitat and destroy host trees that support snails. These activities also promote the spread of non-native plants that displace native plants used by Oahu tree snails. Fire is not a likely threat to Oahu tree snails that occur in wet forested areas. However, given the very low number of occurrences and individuals of Oahu tree snails, any fires that impact these snails would have a significant effect on the overall stability and future survival of the species. For Oahu tree snail occurrences in mesic or dry forest, the threat from fire is an important factor in their long-term conservation. Finally, the small numbers of individuals that remain in each of the Oahu tree snail species may make them highly vulnerable to stochastic effects, such as inbreeding or genetic drift, as well as catastrophic events such as large storms or landslides that could reduce or eliminate any of the smaller occurrences.

<u>Conservation Needs of the Species</u> A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of *Achatinella mustelina*. This plan should include broader landscape actions that are needed for the recovery of the snail throughout its range. The Recovery Plan for the Oahu tree snails identifies important conservation actions. Along with the Makua Implementation Plan actions for *A. mustelina*, these documents should be used to guide ongoing and future conservation actions. The stabilization plan for *A. mustelina* provides a detailed assessment of all the critical tree snail conservation issues actions. Based on the current information on the life history of Oahu tree snails and on the nature of the threats to these snails, the conservation needs of these snails are dependent on the following ecological features: (1) the presence of suitable habitat, which includes a functionally intact native forest with a close or closed canopy and an understory of native plants that can support tree snail occurrences; (2) a population structure that includes all age classes and supports reproductive rates that are high enough to sustain the occurrence; (3) a landscape distribution of occurrences that preserves the remaining genetic diversity of each of the tree snail species; and (4) ecological conditions that can support metapopulation dynamics where specific occurrences may decline or disappear over time while new occurrences within the landscape become established and grow. To achieve these biological requirements, land management actions must (1) effectively control alien species that prey on tree snails, particularly *Euglandina rosea* and all rat species; (2) must protect native forests from excessive disturbance and destruction by ungulates, especially pigs and goats on Oahu; by fire, which can affect some occurrences in the Waianae Mountains; and by invasive non-native plants that can displace native plants used by tree snails; and (3) must assist in protecting existing occurrences and establishing new occurrences throughout the known range of the snail. Captive propagation of tree snails can greatly aid in achieving the conservation needs and management actions. Note, however, that captive populations can undergo occasional declines due to disease or other effects, and that these declines may be rapid. To secure snails using a captive breeding program, a captive population should exceed 100 individuals and there should be two to four populations located at more than one site.

<u>Ongoing Conservation Actions</u> *Achatinella mustelina* is well represented in the tree snail captive propagation facility at the University of Hawaii (approximately 240 individuals in all age classes). Currently, the tree snail captive propagation facility at the University of Hawaii is working at or near maximum capacity. The addition of more species or more individuals from the field will require an expansion in the capacity of the facility. The Nature Conservancy of Hawaii does some management of *A. mustelina* at its Honouliuli Preserve. The State of Hawaii, Department of Land and Natural Resources, funded two snail enclosures for *A. mustelina* at the

Pahole Natural Area Reserve and on the south ridge of Makua Valley. These enclosures exclude rats and predatory snails and are managed by the Army Natural Resources Staff and the State. The Makua Implementation Plan (U.S. Army Garrison 2003) includes predator protection for eight occurrences (each with 300 individuals) of *A. mustelina* throughout the Waianae Mountains. These actions will use a variety of techniques such as poison rat baits, rat snap traps, manual killing of any cannibal snails, and the construction of enclosure fences.

Environmental Baseline

Status of the Species in the Action Area Recent observations (2003 to 2006) show that there are 17 point occurrences (populations) of *Achatinella mustelina* within the Makua action area. The know locations are Kahanahaiki (4 populations, approximately 86 snails); Pahole Gulch (2 populations, 2 snails), Kapuna-Makua ridge (3 populations, approximately 16 snails), and south Makua ridge (8 populations, approximately 358 snails). Four of these populations appear to be stable, two appear to be increasing, and two appear to be decreasing. Eight of the populations have only a single recorded count and one population has no available data; no general trend can be given for these populations.

Within the action area, fourteen of the tree snail populations are within management units that are part of the Makua Implementation Plan: four populations in the Kahanhaiki Management Unit; two populations in the Pahole Management Unit; two populations in the Upper Kapuna Management Unit; and six populations in the Ohikilolo Management Unit. However, only two populations are within fenced areas that protect the snails from rats and alien predatory snails: one in Kahanahaiki (stable at approximately 70 snails) and one in Pahole Gulch (declining with approximately 15 to 30 snails).

Outside of the action area, forty-three populations are within management unit areas. Seven are in the East Makaha Management Unit, one is in the Manuwai Management Unit, eleven are in the Makaha Management Units, two are in the Puu Kumakalii Management Unit, five are in the Puu Hapapa Management Units, eight are in the Puukaua Management Units, and nine are in the Palikea Management Unit. Most of these units have not yet been fenced and receive minimal management actions.

Currently, snails from all six of the evolutionarily significant units (ESUs) are in the Hawaiian tree snail captive propagation facility at the University of Hawaii. In all cases, these populations have not increased to the point that they can provide individuals for reintroduction into the wild; laboratory population sizes range from twelve to thirty individuals (U.S. Army 2006c). Reintroduction into the wild should begin when these populations reach about 300 individuals. Reintroduced snails may be used to establish new populations or enhance existing populations within the appropriate ESU.

Threats in the Action Area. As stated above in the Status of the Species, Threats Section, rats and predatory snails are the greatest threats to the Oahu tree snails and are the major causes of decline and extinction of tree snail occurrences. Other alien species that may prey on Oahu tree snail include two terrestrial flatworms (*Geoplana septemlineata* and *Platydemis manokwari*) and a small terrestrial snail *Oxychilus alliarius*. Additional threats also include loss of habitat from pigs, goats, hiking, hunting, camping, or other activities that can disturb or destroy native habitat, damage tree snail host trees, or spread of non-native plants that displace native plants used by tree snails.

The threat of fire due to military activities in Makua is a concern for some of the occurrences of *Achatinella mustelina* that are within the action area. Uncontrolled fires originating in these areas could destroy tree snail habitat and tree snail occurrences. As assessed by the fire risk modeling (see General Effects section), snails within the action area are at low risk from fire. Finally, small numbers of individuals at each of the occurrences make them vulnerable to stochastic effects, such as inbreeding or genetic drift, as well as catastrophic events such as large storms or landslides that could reduce or eliminate any of the known occurrences.

<u>Conservation Needs in the Action Area</u> A stabilization plan has been developed for *Achatinella mustelina* as part of the Makua Implementation Plan (U.S. Army Garrison 2003). This plan provides a detailed assessment of critical tree snail conservation issues and needs. Based on the *Biological Assessment* (U.S. Army. 2003a) and the Makua Implementation Plan (U.S. Army Garrison 2003), conservation needs on military lands include the following: 1) protect tree snail occurrences from alien species that prey on tree snails, particularly *Euglandina rosea* and all rat species; 2) protect tree snail habitat from disturbance and destruction by ungulates; 3) where conditions and training uses warrant, protect tree snail habitat from fire; 4) control invasive non-native plants that can displace native plants used by tree snails; and 5) employ captive propagation to protect existing occurrences and to support the establishing new occurrences throughout the known range of these snails.

<u>Ongoing Conservation Actions in the Action Area</u> As stated above in the Status of the Species, Ongoing Conservation Actions section, conservation actions for *Achatinella mustelina* are being conducted within the Makua action area and in the snail captive propagation facility at the University of Hawaii. Field conservation actions are mainly focused at monitoring and occasional rat trapping by Army Natural Resources Staff at known occurrences within the Makua action area. The State of Hawaii, Department of Land and Natural Resources operates two snail enclosures for *A. mustelina* within the Pahole Natural Area Reserve and on the south ridge of Makua Valley. These enclosures exclude rats and predatory snails and are managed by the Army Natural Resources Staff and the State. The Makua Implementation Plan (U.S. Army Garrison 2003) includes predator protection for 10 occurrences (each with 300 individuals) of *A. mustelina* throughout the Waianae Mountains. These actions will use a variety of techniques such as poison rat baits, rat snap traps, manual killing of any cannibal snails, and the construction of enclosure fences. At this time, the Makua Implementation Plan for *A. mustelina* is not fully funded and has not been fully implemented.

Status of the Species and Critical Habitat – *Chasiempis sandwichensis ibidis* (Oahu elepaio)

Species Description The Oahu elepaio is a small (12.5 g, 0.4 oz), 15 cm (5.9 in) monarch flycatcher subspecies endemic to the island of Oahu (VanderWerf 1998a). It is dark brown above and white below, with light brown streaks on the breast. The tail is 6.5 cm (2.6 in) long and often held cocked up at an angle. Adults have conspicuous white wingbars, a white rump, and white tips on the tail feathers that are often displayed. The throat is white with black markings in both sexes, but males tend to have more black than females, especially on the chin.

Listing Status Oahu elepaio was federally listed as endangered on April 18, 2000 (65 FR 20760), and was State listed as endangered at the same time. The Revised Hawaiian Forest Birds Recovery Plan (Service 2006c) includes this species, and critical habitat was designated on December 10, 2001 (66 FR 63752).

Historic and Current Distribution Before humans arrived in Hawaii 1,600 years ago, forests covered about 127,000 ha (313,690 ac) of Oahu, and it is likely that elepaio once inhabited much of that area. This species' range is currently limited to approximately 5,451 ha (13,464 ac) (VanderWerf et al. 2001). The Oahu elepaio occupies only about 4 percent of its presumed prehistoric range. As recently as 1975, elepaio inhabited approximately 20,900 ha (51,623 ac) on Oahu, nearly four times the area of the current range (VanderWerf et al. 2001). The range of the elepaio has thus declined by roughly 75 percent in the last 25 years.

In addition to the extent of this species current range decreasing, and despite its adaptability, the total number of Oahu elepaio individuals has dropped significantly since humans arrived (Shallenberger 1977, Shallenberger and Vaughn 1978, Williams 1987, VanderWerf et al. 1997). Based on the dates when elepaio were last observed in various locations, the decline of elepaio began in three areas, the northern Koolau Mountains, the northern slope of Mt. Kaala in the northern Waianae Range, and near Konahuanui in the south-central Koolau Mountains. Perhaps not coincidentally, these are also the three areas with the highest rainfall on Oahu, suggesting mosquito-borne diseases may have played an important role in the decline. Most recent surveys indicate that there are only a total of 7 birds in Makua Valley where in 2001 there had been 26 birds (a 73 percent decline) (S. Mosier, U.S. Army Natural Resources, pers. comm. 2007). Complete surveys of The Nature Conservancy's Honouliuli Preserve indicate that there are a total of 47 Oahu Elepaio on a site where in 2001, there had been 307 (an 85 percent decline) (VanderWerf et al 2000 and VanderWerf 2006). In 2001, the breeding population of Oahu elepaio was estimated to be 1,770 birds with a total population of 1,982, due to a male-biased sex-ratio; only 84 percent of territorial males within large populations have mates (E. VanderWerf, unpubl. data), and many small, declining populations contain mostly males.

Table SB 41. Range-wide Distribution of Oahu elepaio.

Location	2000 (1)	2001 (2)	2006 (6)
Kaluakauila	615	0 / 1	0
Kahanahaiki, Pahole		4 / 14	0 / 1
Makua Valley*		2 / 5	4 / 2
Makaha Valley*		112 / 11	2 / 12
Makaha Valley*			28 / 24
Waianae Kai			Incomplete surveys
Schofield Ranges*		310 / 36	Incomplete surveys
Waianae (other)		2 / 6	Incomplete surveys
Ekahanui		138 / 13	Incomplete surveys
Honouliuli*		280 / 27	26 / 21
Moanalua Valley*	885	206 / 20	Incomplete surveys
Waikana / Kahana Valley*		26 / 0	Incomplete surveys
Koolau Mts (elsewhere)		696 / 73	Incomplete surveys
Total Individuals	1,500	1,982	< 1,703

Shaded population units are inside the action area.
*Army currently conducts predator control
‡Total breeding birds / total single birds

(1) Listing rule (65 FR 20760)
(2) VanderWerf et al. (2001)
(3) Final Implementation Plan (Makua Implementation Team 2003), Oahu biological opinion (Service 2003a)
(4) Addendum to Final Implementation Plan and 2004 status report (U.S. Army Garrison 2005a, 2004)
(5) 2005 status update (U.S. Army Garrison 2005b)
(6) 2006 status update (U.S. Army Garrison 2006c), Recovery plan (Service 2006c)

The genetically-effective population size probably is further reduced by the geographic isolation of populations (Grant and Grant 1992). Adults have high site fidelity and natal dispersal distances usually are less than a km (0.6 mi) (VanderWerf 1998a), but most elepaio populations on Oahu are separated by many kilometers of unsuitable urban or agricultural habitat. There may be infrequent dispersal among populations within each mountain range, but it is unlikely that elepaio cross the extensive pineapple fields that separate the Waianae and Koolau Mountains. The current distribution appears to constitute a metapopulation (Hanski and Gilpin 1997). Investigation of the genetic population structure has begun (Burgess 2005), but requires additional analysis.

Ecology   Elepaio are non-migratory and defend all-purpose territories year-round (Conant 1977, VanderWerf 1998a). The average territory size is 2.0 ha (4.9 ac) in a forest composed of alien plant species in Manoa Valley (Conant 1977) and ranged from 1.2 to 1.8 ha (3.1 to 4.5 ac) in three valleys in southeastern Oahu, depending on forest structure (VanderWerf and Smith 2002). Annual survival is high, 81 percent in the absence of predation by alien mammals, but survival of females is heavily impacted by predation from alien rats (VanderWerf and Smith 2002). Elepaio are socially monogamous and have high mate and site fidelity; in the absence of predation by alien mammals, 97 percent of males and 95 percent of females remain on the same territory between years, and nearly all pairs remain together between years (VanderWerf and Smith 2002). Young birds are subordinate and act as floaters while they attempt to acquire a territory and a mate. The nesting season usually extends from February to May, but active nests have been found from January to July (VanderWerf 1998a).

The nest is a finely-woven, free standing cup made of rootlets, bark strips, leaf skeletons, lichens, and spider silk, and is placed in a fork or on top of a branch (Conant 1977, VanderWerf 1998a). Nests have been found in a variety of plants, including 7 native species and 15 introduced species (E. VanderWerf, unpubl. data). Oahu elepaio nests are built 2 to 19 m (6 to 62 ft) off the ground in shrubs and trees (VanderWerf and Smith 2002). Both sexes participate in all aspects of reproduction, but the female plays a slightly greater role in nest building and the male provides more food for the nestlings (VanderWerf 1998a). Although both sexes incubate and brood, only the female develops a brood patch and only the female incubates at night. Clutch size is usually two, sometimes one or three, and eggs hatch after 18 days (Conant 1977, VanderWerf 1998a). The nestling period averages 16 days, and fledglings are fed by their parents for more than a month after leaving the nest, remaining on the natal territory for up to 9 months at the start of the next breeding season (VanderWerf 1998a). Fecundity is low; even if nest predators are controlled, the mean number of fledglings per pair is 0.70 per year (VanderWerf and Smith 2002). Oahu elepaio will re-nest once or twice after failure, but they rarely attempt to re-nest if the first nest is successful. Other than introduced predators, the most common cause of nest failure is storms with heavy rain and strong winds (VanderWerf 1998a).

Survival and reproduction of Oahu elepaio vary considerably among years (VanderWerf and Smith 2002; E. VanderWerf, unpubl. data), probably in association with climatic factors that affect populations of nest predators and disease-carrying mosquitoes. These annual variations are stochastic, but the average interval of between occurrences of both rodent irruptions and disease episodes is approximately 5 years. Demographic monitoring from 1995 to 2006 revealed that there were 2 years (1996 and 2004) with high disease prevalence and 2 years (1999 and 2004) with high rodent abundance (E. VanderWerf, unpubl data). Conditions that increase the severity of these two threats do not necessarily coincide, and elepaio populations therefore can be expected to fluctuate over time in a complex pattern.

The foraging behavior and diet of elepaio are extremely varied. In a study on Hawaii Island, VanderWerf (1993, 1994) found that elepaio foraged at all heights on all available plant species, and that they caught insects from a variety of substrates, including the ground and fallen logs (2 percent), trunks (5 percent), branches (24 percent), twigs (38 percent), foliage (20 percent), and in the air (11 percent). Elepaio are versatile and agile in pursuit of prey, using a diversity of foraging behaviors that is among the highest recorded for any bird, including perch-gleaning (48 percent), several forms of flight-gleaning (30 percent), hanging (11 percent), aerial flycatching (7 percent), and active pursuit (four percent) (VanderWerf 1994). The diet consists of a wide range of arthropods, particularly insects and spiders, and includes nonnative taxa such as fruit flies (VanderWerf 1998a). Large prey such as moths and caterpillars are beaten against a branch before being eaten.

Oahu elepaio are adaptable and occur in a variety of forest types composed of both native and introduced species (Conant 1977; VanderWerf 1993, 1994, 1998a). Plant species composition in elepaio habitat varies considerably depending on location and elevation, but some of the most common native plants in areas where elepaio occur are alahee (*Psydrax odorata*), papala kepau (*Pisonia umbellifera*), lama (*Diospyros sandwicensis*), hame (*Antidesma platyphyllum*), mamaki (*Pipturus albidus*), kaulu (*Sapindus oahuensis*), and alaa (*Pouteria sandwicensis*), and some of the most common introduced plants are strawberry guava (*Psidium cattleianum*), common guava (*Psidium guajava*), kukui (*Aleurites moluccana*), mango (*Mangifera indica*), and Christmas berry (*Schinus terebinthifolius*) (VanderWerf et al. 1997, VanderWerf 1998a). Nest site selection by Oahu elepaio is non-specialized; nests have been found in 7 native and 15 introduced plant species (E. VanderWerf, unpubl. data). Shallenberger and Vaughn (1978) found the highest relative abundance of elepaio in forest dominated by introduced guava (*Psidium* spp.) and kukui (*Aleurites moluccana*) trees, but they were also found in the following forest types (in order of decreasing abundance): mixed native-exotic; tall exotic; koa (*Acacia koa*) dominant; mixed koa-ohia (*Metrosideros polymorpha*); low exotic; Ohia dominant; and Ohia scrub. They currently are not found in very wet, stunted forest on windswept summits or in very dry scrubland. Unlike many Hawaiian forest birds, elepaio have adapted well to disturbed forest composed of introduced plants (Conant 1977, VanderWerf 1998a). VanderWerf et al. (1997) found that: 1) forest structure was more important to elepaio than plant species composition, 2) most elepaio occurred in areas with a continuous forest canopy and a dense understory, and 3) population density was roughly twice as high in tall riparian vegetation in valleys than in scrubby vegetation on ridges. Fifty-five percent of the elepaio's current range is dominated by introduced plants, and 45 percent is dominated by native plants (VanderWerf et al. 2001). This does not imply that elepaio prefer introduced plant species, but simply reflects a preference by elepaio for riparian vegetation in valleys and the high degree of habitat disturbance and abundance of alien plants in these riparian areas (VanderWerf et al. 1997). Of the 45 percent dominated by native plants, 23 percent is categorized as wet forest, 17 percent as mesic forest, and 5 percent as dry forest, shrubland, and cliffs (Hawaii Heritage Program 1991).

<u>Threats to the Species</u> Habitat loss, predator and disease impacts have resulted in significant reductions in Oahua elepaio numbers over the past 25 years. Much of the historical decline of the Oahu elepaio can be attributed to habitat loss, especially at low elevations. Fifty-six percent of the original prehistoric range has been developed for urban or agricultural use, and no elepaio remain in these developed areas (VanderWerf et al. 2001). Habitat loss thus has been a major cause of decline, but elepaio are adaptable, and moderate habitat alteration in the form of gradual replacement of native forest with alien forest has not limited their distribution (VanderWerf et al. 1997). Moreover, several areas of Oahu that recently supported large elepaio populations and still contain suitable native forest habitat are unoccupied, demonstrating that habitat loss is not the only threat. Elepaio were observed regularly into the 1970s or early 1980s at Poamoho, Schofield-Waikāne, Mānana, and other areas (Shallenberger 1977, Shallenberger and Vaughn 1978), but they have since disappeared from all of these areas even though the forest is still largely intact (VanderWerf et al. 2001).

Recent declines in Oahu elepaio populations are due to a combination of low adult survival and low reproductive success. The two main causes of reduced survival and reproduction on Oahu are nest predation by alien black rats (*Rattus rattus*) and diseases, particularly avian pox (*Poxvirus avium*), which is carried by the introduced southern house mosquito (*Culex quinquefasciatus*) and avian malaria (*Plasmodium relictum*).

Fires ignited by the public and military training activities are a serious long-term threat to elepaio and have reduced the amount of suitable habitat for the species, including areas designated as critical habitat for the Oahu elepaio (Service 2003c). Fire removes habitat, which is replaced by nonnative fire-adapted plants that are not used by elepaio, such as swamp mahogany (*Eucalyptus robusta*) and bottlebrush (*Melaleuca quinquenervia*). If this pattern is allowed to continue, there eventually will be no mesic forest left at Schofield Barracks and Makua Valley, and those populations will be lost. Oahu elepaio also are threatened by human actions, such as the potential introduction of the brown treesnake (*Boiga irregularis*) from the Mariana Islands, which has devastated the avifauna on Guam (Savidge 1987). A study of the effects of noise from military training showed that Oahu elepaio at U.S. Army Schofield Barracks are not affected by noise from military training (VanderWerf et al. 2000).

The remaining elepaio populations are small and isolated, comprising 6 core populations that contain between 100 and 500 birds each, and several small remnant populations, most of which contain fewer than 10 birds and few or no breeding pairs. Even if the threats responsible for their decline are controlled, the existing populations will still be threatened with extinction because their small sizes and restricted distributions make them vulnerable to a variety of natural processes, including reduced reproductive vigor caused by inbreeding depression, loss of genetic variability and evolutionary potential over time due to random genetic drift, stochastic fluctuations in population size and sex ratio, and natural disasters such as hurricanes and fires (Lande 1988, International Union for the Conservation of Nature 2000).

<u>Conservation Needs of the Species</u> Conservation efforts for the Oahu elepaio include surveys to determine current distribution and abundance (VanderWerf et al. 1997, 2001), demographic monitoring to assess population status and identify threats (VanderWerf 1999), removal of introduced predators (VanderWerf and Smith 2002), and investigation and control of disease. Long-term demographic studies have shown that the two most important current threats are nest predation by black rats and introduced mosquito-borne diseases. Rat control is a promising conservation technique for increasing both reproductive success and survival of adult females. Populations which do not receive rodent control decline at an average rate of 24 percent per year, while sites with rodent control, on average, remain unchanged (VanderWerf and Smith 2002).

<u>Ongoing Conservation Actions</u> Ground-based rodent control using snap traps and diphacinone bait stations has been conducted in the Honolulu Watershed Forest Reserve by the Hawaii State Division of Forestry and Wildlife since 1997, at Schofield Barracks West Range and Makua by the U.S. Army Environmental Division since 1998, at Honouliuli Preserve by The Nature Conservancy of Hawaii since 2000, in Lualualei Naval Magazine by the U.S. Navy and U.S. Department of Agriculture, Wildlife Services from 2002 to 2004, in Makaha Valley by the City and County of Honolulu Board of Water Supply and the U.S. Army since 2004, and in and Moanalua Valley by the U.S. Army since 2005. Blood samples have been collected from over

150 elepaio for use in disease screening, determination of genetic population structure, and to assist in identification of potentially disease-resistant populations or individuals.

Critical Habitat Description Critical habitat for the Oahu elepaio was designated in five units totaling 26,661 ha (65,879 ac), primarily encompassing undeveloped high elevation areas of the island. Lands designated as critical habitat provide the full range of primary constituent elements needed by the Oahu elepaio, including: a variety of undeveloped forested areas that are currently occupied by elepaio and used for foraging, roosting, sheltering, nesting, and raising offspring; a variety of currently unoccupied undeveloped forested areas that are adjacent to occupied areas and provide for conservation of the species through expansion of existing subpopulations; and shrub land and cliff habitats that link populations and can be used for dispersal. If elepaio were restored throughout each of the critical habitat units, the resulting distribution would resemble the distribution in 1975, when elepaio populations were larger and less isolated, the overall population appeared to be viable, and the Oahu elepaio was not considered endangered.

Critical habitat for the Oahu elepaio was designated on December 10, 2001, to provide additional protection for occupied and unoccupied lands considered essential to the conservation of the species (66 FR 63752). The primary constituent elements required by Oahu elepaio for foraging, sheltering, roosting, nesting, and rearing of young are undeveloped wet, mesic, and dry forest habitats composed of native or introduced plant species. Higher population density can be expected in tall, mesic, closed-canopy riparian forest with a well-developed understory than in dry, low-stature, or scrubby forest on ridges and summits, but elepaio are adaptable and able to forage and nest in a variety of forest types composed of both native and introduced plant species (Conant 1977, VanderWerf 1993, 1994, 1998). Nest site selection by elepaio is non-specialized; nests have been found in seven native and 13 introduced plant species (E. VanderWerf, unpubl. data). In addition, the primary constituent elements associated with the biological needs of dispersal and genetic exchange among populations are undeveloped wet or dry shrub land and wet or dry cliff habitats. Elepaio may not establish territories in shrub or cliff habitats and may use them only transiently, but areas containing these habitats are important for linking populations by providing opportunities for birds to disperse among populations, thereby exchanging genetic information and increasing the effective population size.

Critical habitat for the Oahu elepaio includes land under Federal, State, and private ownership, with Federal lands being managed by the Department of Defense and the Department of the Interior. Designated lands include most (99 percent) of the species' current range and encompass approximately 21 percent of the species'original range. Approximately 22 percent of designated lands are currently occupied by elepaio, and 78 percent are currently unoccupied but were occupied recently (since 1975) and are generally still suitable. A detailed description of each critical habitat unit and reasons for designating each portion of the unit as critical habitat are presented below. A detailed description of the critical habitat unit that encompasses the action area is presented below.

Unit 1 Northern Waianae Mountains: Unit 1 consists of approximately 4,454 ha (11,005 ac) encompassing the higher elevations of the northern Waianae Mountains, including a large portion of the Makua action area. The unit is bounded on the south by Kolekole Pass, and on the north, east, and west by forest edge created by human actions. Natural features within the unit include Mt. Kaala, the highest peak on Oahu at 1,227 m (4,025 ft), several other high peaks along the spine of the Waianae Range, and the upper portions of valleys and slopes, including Waianae Kai, Makaha, Makua, Kahanahaiki, and Kuaokala valleys on the west slope, Haleauau and Mohiakea gulches on the east slope, and several narrow valleys on the north slope. Vegetation consists primarily of mixed-species wet, mesic, and dry forest communities composed of native and introduced plants, with smaller amounts of dry shrub land and cliff plant communities (Hawaii Heritage Program 1991).

Unit 1 contains two important "core" elepaio populations: one in upper Haleauau and Mohiakea gulches above the firebreak road on U.S. Army Schofield Barracks West Range, and the other in upper Makaha and Waianae Kai valleys on Waianae Kai State Forest Reserve and City and County of Honolulu land. The unit also includes scattered small elepaio populations in Pahole and Kaala State Natural Area Reserves, Mokuleia, Makua-Keaau, and Kuaokala State Forest Reserves, and the upper portion of the Makua installation. Thirty percent of Unit 1 is currently occupied by elepaio. Approximately 70 percent of critical habitat lands on the West Range of Schofield Barracks are currently occupied by elepaio. Elepaio in the northern, leeward (western) Waianae Mountains are morphologically and behaviorally distinct from elepaio in other parts of the island, and conservation of the full range of morphological and ecological diversity present in the species would not be possible without the populations in the northern Waianae Mountains.

In addition to protecting lands occupied by two core elepaio populations and six smaller populations, designated lands in Unit 1 provide for expansion of these populations by including currently unoccupied lands that were occupied within the past 30 years and that still contain the types of forest most preferred by elepaio. Specifically, currently unoccupied lands in Pahole and Kaala State Natural Area Reserves, Mokuleia, Makua-Keaau, and Kuaokala State Forest Reserves, upper Makua Valley, and upper Kahanahaiki Valley are needed for recovery to allow the number of birds in existing populations to increase. The current distribution of elepaio in Unit 1 represents a remnant of what was once a single, large, continuous elepaio population in the northern Waianae Mountains. Inclusion of currently unoccupied forested lands that provide for expansion and shrub land and cliff habitats that provide for dispersal among populations will provide linkage needed to approximate the original genetic and demographic conditions that once existed in this area.

<u>Threats to the Critical Habitat</u> The primary threats to elepaio critical habitat are fires, browsing by feral goats, rooting by feral pigs, predation by rats on seeds of native plant species, and replacement of native forest by alien plant species. Fires degrade or destroy the primary constituent elements needed by elepaio by directly burning forest and by facilitating the expansion of fire adapted alien plant species that are not useful to elepaio, such as *Eucalyptus robusta*, silk oak (*Grevillea robusta*), ironwood (*Casuarina* spp.), and California grass (*Brachiaria mutica*), which grow back after a fire more rapidly than native plant species. Browsing by feral goats, rooting by feral pigs, and seed predation by rats can reduce the density of canopy tree species, thin the forest under story, inhibit recruitment of trees and shrubs, and increase erosion, thereby diminishing the long-term structural integrity of the forest.

Environmental Baseline of the Species and Critical Habitat

Status of the Species in the Action Area Within the action area elepaio maintain territories in Kahanahaiki and Ohikilolo Management Units, the East Rim area of the valley, and the Makaha Valley. Currently, a total of 16 Oahu elepaio maintain territories within the Makua action area (3 pairs, 1 single female, and 9 single male birds). Seven of these birds have been captured and banded. Areas outside Makua, but within the Makua action area, that have previously harbored elepaio include the Mokuleia Forest Reserve (Kuaokala) and the Pahole Natural Area Reserve. Most recent surveys indicate that there are only 7 birds in Makua Valley where there had been 26 birds in 2001.

Table SB 42. Historic Elepaio Nesting at Makua
MMR-01 Kahanahaiki (Male: GBAR & Female BABW)

Year	# of Nests Observed	# of Successful Nests	Family Group Observed	# of Fledglings Observed
1996	1	0	0	0
1997	1	0	0	0
1998	0	0	1	1
1999	0	0	0	0
2000	0	0	0	0
2001	1	1	0	1
2002	1	1	0	2
2003	2	1	0	1
2004	2	1	0	1
2005				
2006				
2007				
Total	**8**	**4**	**1**	**6**

Only single female (BABW) in territory: 2005, 2006, and 2007

MMR-02 (Male: ARGB & Female Unbanded)

Year	# of Nests Observed	# of Successful Nests	Family Group Observed	# of Fledglings Observed
2001	0	0	0	0
2002	0	0	0	0
2003	1	0	0	0
2004	0	0	0	0
2005	No Access to Lower Makua			
2006	0	0	0	0
2007	Current Season			
Total	**1**	**0**	**0**	**0**

MRR-03 (Male: ABBB & Female: AGWR)

Year	# of Nests Observed	# of Successful Nests	Family Group Observed	# of Fledglings Observed
2002	0	0	0	0
2003	1	0	0	0
2004	1	0	0	0
2005	No Access to Lower Makua			
2006	0	0	0	0
2007	Current Season			
Total	**2**	**0**	**0**	**0**

Status of the Critical Habitat in the Action Area The Makua action area includes 1,106 hectares (2,734 acres) of Oahu elepaio critical habitat in Unit 1 (66 FR 63752). Elepaio critical habitat in the Makua action area represents approximately 4 percent of the 26,868 hectares (66,390 ac) designated as critical habitat for this species on the island, and approximately 36 percent of critical habitat Unit 1. The lower boundary of critical habitat within the Makua action area roughly follows the forest edge, with areas below the critical habitat covered by dry shrubland and grass-dominated communities.

The critical habitat lands within the Makua action area are part of what once was a large, continuous elepaio population in the northern Waianae Mountains. As described in the Revised Recovery Plan Hawaiian Forest Bird (Service 2006c), recovery of the Oahu elepaio will require restoration of populations that represent the geographic, morphological, and behavioral variation within the species. Elepaio on the drier, western side of the Waianae Range are paler and grayer than elepaio in other areas, and elepaio vocalizations vary between the Waianae and Koolau Mountains and among valleys within the Waianae Mountains (VanderWerf 1998, unpubl. data), so the elepaio in Makua Valley are needed to represent the complete geographic, morphological, and behavioral variation. The loss of Makua would decrease the potential size of any elepaio population in the northern Waianae Range, would cause a gap in the distribution of elepaio on the western side of the Waianae Range, would inhibit dispersal and genetic exchange among populations to the north and south, and thus would reduce the possibility of restoring a viable population in the northern Waianae Mountains. In addition to lands occupied by the two core elepaio populations and six smaller populations, Unit 1 provides for expansion of existing populations by including currently unoccupied lands that were occupied within the past 30 years and contain the types of forest most preferred by elepaio.

Threats to the Species and Critical Habitat in the Action Area Wildland fire, disease, predation, and feral ungulate disturbance impact Oahu elepaio and elepaio critical habitat in the action area. Of the 1,106 ha (2,734 ac) of elepaio critical habitat in the Makua Action Area, 178 ha (441 ac) are in the high fire risk zone, 388 ha (960 ac) are located in the low fire risk zone, and 540 ha (1,333 ac) occur in the very low fire risk zone. In September 2003, a prescribed burn at the Makua installation escaped containment and resulted in an uncontrolled fire that burned approximately 61 ha (150 ac) of designated Oahu elepaio critical habitat within the Makua action area. Some of this area consisted of dry shrubland that would have been used by elepaio only for dispersal, but the fire also burned parts of three elepaio territories that were occupied by single males. These burned areas no longer contain the primary constituent elements needed by elepaio for foraging, nesting, sheltering, or dispersal and thus have lost their function. Browsing by feral goats and rooting by feral pigs has degraded the quality of the primary constituent elements in portions of elepaio critical habitat within the action area by reducing the forest density and inhibiting recruitment of native plants.

Conservation Needs of the Species and Critical Habitat in the Action Area Habitat loss, nest predation by alien black rats and diseases are the main causes of the decline in numbers of Oahu elepaio. Historically habitat loss resulting from escaped fires caused by Army training has occurred within the action area. Additionally, non-military wildfire sources also occur within the action area. Non-military wildfire sources include arson and accidental ignitions by cigarettes, fireworks, and campfires. Fire destroys native vegetation and wildlife, and facilitates conversion of native habitats to alien-dominated cover types with dense grass fuel loads that favor future fires (see General Effects). Elepaio rely on mesic forest vegetation and grass-dominated ecosystems are not suitable habitat for elepaio. In order to minimize the loss of habitat resulting from wildfires, a post-fire revegetation plan and site-specific fuels modification plan are needed where elepaio, and elepaio critical habitat, are present in the action area.

Feral ungulates (goats and pigs) also reduce the extent of suitable habitat by degrading native ecosystems via trampling and uprooting vegetation, increasing erosion, and spreading seeds of invasive plants. To prevent the further degradation of habitat by feral ungulates, areas of designated elepaio critical habitat, as well as areas with suitable habitat for elepaio, should be fenced and ungulates removed.

Nest predation by black rats also effects survivorship and recruitment of Oahu elepaio. Elimination of rats in territories with Oahu elepaio will increase the survival and recruitment of this species. Currently bait stations, live traps and snap traps are the only feasible and approved means of controlling rats. If aerial rodenticide is approved for use, this will be a more feasible and effective method controlling of rats and should be used to eliminate rats from Oahu eleapaio breeding territories and potential territories.

Other general conservation needs of the species and critical habitat in the action area are the same as those described in the introduction to the Status and Environmental Baseline of the Species and Critical Habitat section.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area The Army has implemented a Wildland Fire Management Plan and maintains a firebreak road in Makua that reduces the risk of and helps prevent fires escaping the impact area and burning areas of critical habitat. The Army also conducts a variety of management actions aimed at conserving and restoring native forest in various management units throughout the action area, including control of feral goats and pigs, control of non-native plants to reduce competition with native plant species and to reduce the risk of fire. Approximately 30 percent of elepaio critical habitat within the action area coincides with these management units and thus benefits from these actions, including Keaau Ohikilolo (93 ha; 229 ac), West Makaleha (33 ha; 81 ac), Upper Kapuna (55 ha; 136 ac), Upper Kapuna sub-unit (12 ha; 29 ac), Pahole (87 ha; 215 ac), Kahanahaiki (37 ha; 93 ac), and Kaluakauila (20 ha; 50 ac).

The Army Natural Resources Staff survey for elepaio and control rats in the Ohikilolo Management Unit, the East Rim Ungulate Control Area, the Kahanahaiki Management Unit and Makaha Valley. Since 2001, the Army Natural Resources Staff have controlled predators within territories of known pairs of Oahu elepaio within the Ohikilolo Management Unit. Predator control was initiated in 2002 for the pair located in the East Rim Ungulate Control Area. From 1996 until the 2006 breeding season, the Army Natural Resources Staff have conducted predator control around the breeding pair within the Kahanahaiki Management Unit. This pair has successfully fledged young over the years. Since 1998, 132 rats have been snap trapped, 25 mongoose and 8 feral cats live trapped from the elepaio breeding territory in the Kahanahaiki Management Unit.

GENERAL EFFECTS - OVERVIEW

The "General Effects" section summarizes the adverse impacts of Army training at Makua that potentially will affect 38 plant taxa, the Oahu tree snail, the Oahu elepaio, and critical habitat for 36 plant taxa and the Oahu elepaio. This overview summarizes the ecosystem-level effects of the proposed action that will impact all these listed resources similarly. However, here we focus on general effects to plants; effects to the Oahu elepaio and Oahu tree snail will be treated separately. Actions to avoid and minimize these impacts also are summarized jointly. Following this general discussion, we address these general effects for six groups of listed resources covered by this Biological Opinion: (1) 16 target plant taxa identified for stabilization in the Makua Implementation Plan Addendum, (2) 12 at-risk plant taxa identified for expedited stabilization, (3) 11 plant taxa that do not require active stabilization measures, (4) designated critical habitat for 36 plant taxa, (5) the Oahu tree snail *Achatinella mustelina*, and (6) the Oahu elepaio and its designated critical habitat. Taxa included within the four plant groupings are tabulated below. The group effects analyses also include pertinent details for each species and critical habitat.

<u>Stabilization Target Plant Taxa</u>

Alectryon macrococcus var. *macrococcus*
Cenchrus agrimonioides var. *agrimonioides*
Chamaesyce celastroides var. *kaenana*
Cyrtandra dentata
Dubautia herbstobatae
Flueggea neowawraea
Hedyotis degeneri var. *degeneri*
Hedyotis parvula
Hesperomannia arbuscula
Melanthera tenuifolia
Nototrichium humile
Plantago princeps var. *princeps*
Pritchardia kaalae
Schiedea kaalae
Tetramolopium filiforme
Viola chamissoniana ssp. *chamissoniana*

<u>Expedited Stabilization Target Plant Taxa</u>

Chamaesyce herbstii
Cyanea grimesiana ssp. *obatae*
Cyanea longiflora
Cyanea superba ssp. *superba*
Delissea subcordata
Gouania vitifolia
Hibiscus brackenridegei ssp. *mokuleianus*
Neraudia angulata
Phyllostegia kaalaensis
Sanicula mariversa
Schiedea nuttallii
Schiedea obovata

<u>Non-Stabilization Plant Taxa</u>

Abutilon sandwicense
Bonamia menziesii
Ctenitis squamigera
Diellia falcata
Euphorbia haeleeleana
Lepidium arbuscula
Lobelia niihauensis
Peucedanum sandwicense
Schiedea hookeri
Silene lanceolata
Spermolepis hawaiiensis

Plant Critical Habitat

Bonamia menziesii
Cenchrus agrimonioides var. *agrimonioides*
Chamaesyce celastroides var. *kaenana*
Chamaesyce herbstii
Colubrina oppositifolia
Cyanea grimesiana ssp. *obatae*
Cyanea longiflora
Cyanea superba ssp. *superba*
Cyrtandra dentata
Delissea subcordata
Diellia falcata
Dubautia herbstobatae
Euphorbia haeleeleana
Flueggea neowawraea
Gouania vitifolia
Hedyotis degeneri var. *degeneri*
Hedyotis parvula
Hesperomannia arbuscula
Hibiscus brackenridgei ssp. *mokuleianus*
Isodendrion laurifolium
Isodendrion longifolium
Isodendrion pyrifolium
Mariscus pennatiformis
Melanthera tenuifolia
Melicope pallida
Neraudia angulata
Nototrichium humile
Phyllostegia kaalaensis
Plantago princeps var. *princeps*
Sanicula mariversa
Schiedea hookeri
Schiedea kaalae
Schiedea nuttallii
Schiedea obovata
Solanum sandwicense
Spermolepis hawaiiensis

Exposure Analysis Approach

The Service has developed an analysis framework for Section 7 consultations that incorporates the general structure, primary concepts, and nomenclature of the U.S. Environmental Protection Agency's ecological risk assessment framework (Service 2005a). Factors causing adverse effects or impacts are called "stressors" and beneficial effects are called "subsidies." In this approach, the Service determines the listed resources that will be exposed to the proposed action's stressors and subsidies. First, the location, timing, duration, frequency, and intensity of potential exposure to each stressor and subsidy are used to delineate the action area and to identify the physical, chemical, and biotic features that will be directly and indirectly exposed. Then the causal relationships between sources of stressors and subsidies and the response of listed resources are analyzed. The exposure analysis also estimates future changes in the abundance or distribution of listed species expected to result from exposure to stressors and subsidies, as well as future changes in the quality, quantity, and availability of primary constituent elements of critical habitat.

General Effects of the Proposed Action on Listed Species

Physical features within the Makua action area that will be exposed to project stressors and subsidies include cliffs, gulches, and other topographic and microclimate conditions. Chemical features include temperature and soil nutrient/moisture relations, and biotic features include vegetation types and their associated plant and animal species. Most of the proposed action's stressors are associated with military training activities, including the use of various weapons systems and munitions, mounted maneuvers (using vehicles and aircraft), and ground maneuvers (troop marches, bivouac, etc.). Most of the subsidies are associated with the Army's conservation and stewardship programs, including the Wildland Fire Management Plan, Integrated Natural Resource Management Plan, Integrated Training Area Management (ITAM), and Makua Implementation Plan Addendum.

Individual listed plants, tree snails, elepaio, and primary constituent elements of critical habitat will be exposed to three major sources of stressors: (1) training-related wildfire (heat, flames, smoke, and ash associated with fires ignited by weapons systems and munitions); (2) introduction and spread of non-native plants, animals, and invertebrates (trampling, grazing, soil erosion, predation, herbivory, competition, and disease); and (3) human disturbance (trampling, soil erosion, and plant breakage). In addition to the stressors listed above, the Oahu elepaio will be exposed to noise stressors (auditory disturbance associated with ordnance and aircraft). Regarding the effects of fire, this Biological Opinion focuses on the effects of training-related wildfire, usually ignited by weaponry used during live-fire exercises. Training-related wildfire also includes the spontaneous ignition of old, buried white phosphorus rounds that may become exposed to the air and accidental detonation of unexploded ordnance. The proposed action also includes protocols for prescribed burns to reduce fuel loads in the training impact area inside the firebreak roads. Prescribed burns have escaped the firebreak roads in the past, with impacts to listed resources. Conformance with the proposed action's burn prescription, however, will preclude future escapes. Although the possibility exists that properly managed prescribed burns may escape the firebreak roads, the risk is considered negligible.

Subsidies associated with the proposed action's conservation and stewardship programs are intended to minimize the exposure of listed resources to project stressors. Five major sources of subsidies include: (1) Wildland Fire Management Plan and ITAM activities (fire suppression and fuels management to reduce the ignition and spread of training-related wildfire), (2) habitat management activities to control invasive species (fencing, weeding, invertebrate pest removal, and phytosanitation measures), (3) stabilization activities for target plant and Oahu tree snail population units (outplanting to augment and reintroduce plants, and captive propagation of tree snails), (4) rat control to reduce predation on Oahu tree snails and Oahu elepaio, and (5) standard operating procedures (to reduce the impacts of human disturbance and damage to soils and native plants).

The response of listed resources to direct and indirect exposure to the proposed action's stressors and subsidies involves three types of effects. Effects of direct exposure to stressors (i.e., direct effects) include immediate injury or death of individual plants, tree snails, and elepaio, and destruction of primary constituent elements of critical habitat. Effects of indirect exposure (i.e., indirect effects) are caused by the proposed action and occur later in time, but are reasonably certain to occur. Beneficial effects of subsidies are contemporaneous positive effects without any adverse effects to the species. Any short-term negative effects associated with beneficial actions are insignificant (never reaching the scale where take of listed animals or loss of listed plants occurs) or discountable (undetectable and extremely unlikely to occur). The major response variables evaluated in this opinion's effects analyses for covered plants are the number of stable population units for each taxon, which is determined according to the number of mature, reproducing individuals that comprise each population unit managed for stability.

Direct effects caused by training-related wildfire, trampling and grazing by feral ungulates, herbivory by rats (*Rattus* spp.) and invertebrates, and trampling by troops will immediately injure or destroy individuals or entire occurrences of listed plants, tree snails, elepaio, and constituent elements of critical habitat. Indirect effects of fire, trampling, and non-native animals and invertebrates will result in loss or degradation of habitat by injuring listed species, removing vegetation cover, altering microclimate and soil nutrient/moisture regimes, reducing the vigor of surviving plants, and altering patterns of plant community composition and succession. Habitat destruction by fire also will drive pigs (*Sus scrofa*), goats (*Capra hircus*), and rats from burned areas into adjacent areas occupied by listed species and into critical habitat units. Additional indirect effects to species and critical habitats will result from the introduction and spread of non-native invasive plants through the movement of troops, maintenance crews, natural resources staff, vehicles, and equipment. The quality, quantity, and availability of constituent elements for critical habitat also will diminish due to erosion, microclimate changes, competition by alien plants for growing space and resources, and changes in species composition due to loss of native species and invasion of alien plants. Indirect beneficial effects (subsidies) include increased survival of listed species and enhanced value of critical habitat due to fire suppression, fuels management, control of non-native species, and endangered species stabilization.

Most of the adverse impacts of military training will be located within the PFC Pililaau Range Complex ("training impact area") within the north and south firebreak roads, where listed resources will not be affected. However, there is a risk of fire ignition and spread outside the firebreak roads to areas where listed species and critical habitats are located. Listed resources will also be exposed to other project stressors and subsidies throughout the action area (Table E 1).

Table E 1. Area Impacted by Training.

Action Area	Hectares	Acres
Makua Military Reservation		
Training Impact Area	460	1,136
South firebreak road	185	457
North firebreak road	144	355
Outside Training Impact Area	1,236	3,054

General Effects of the Proposed Action on Plant Critical Habitat

The Army's proposed action is likely to adversely affect designated critical habitats in similar ways throughout the action area. All critical habitats within the action area are parts of larger critical habitat units that extend beyond the action area to provide habitat capable of supporting one or more populations of the listed species.

In the action area, some critical habitat areas are located in fire risk zones where they will be exposed to project stressors associated with training-related wildfire, introduction and spread of invasive species, and physical disturbance associated with human activities. Some critical habitat areas are located in management units where primary constituent elements will be exposed to project subsidies associated with endangered plant stabilization. The stressors and subsidies to critical habitat are similar in effect to those described above for listed plants. Likewise, primary constituent elements of critical habitat that will be exposed to stressors and subsidies include the same physical, chemical, and biotic features described above for listed plants. These constituent elements are expected to change in quality, quantity, or availability in response to direct and indirect exposure to project stressors and subsidies in much the same way as discussed above for listed plants. For example, fire will degrade critical habitat by removing native plant cover in mixed native and non-native forest, which will facilitate the invasion of non-native invasive plants and further inhibit the natural regeneration of native vegetation. Without active management, burned areas in Hawaii do not recover their native plant components, and alien grass cover predisposes adjacent areas to burn in future fires. Eventually a succession of fires will convert native ecosystems to non-native grasslands and shrublands.

In contrast, subsidies associated with Wildland Fire Management Plan, ITAM, and Makua Implementation Plan Addendum activities will enhance the conservation value of critical habitat by decreasing the risk of fire ignition and spread, reducing the fuel load of alien grasses, and excluding feral ungulates. Some critical habitat areas within the action area are located within or adjacent to endangered plant management units, and thus are separated from the training impact area by zones of low or very low fire risk. In addition, Army stabilization of target taxa and revegetation of burned critical habitat areas will help replace primary constituent elements. A temporary loss of function of some critical habitat units may occur during the revegetation process. Over the long-term, however, revegetation of burned critical habitat in the action area will contribute to the conservation value of larger critical habitat units essential for conservation of the species. Without these project subsidies, critical habitat in the action area eventually would lose most of the primary constituent elements essential to species' survival and recovery because of the ongoing impacts of non-native ungulates and plants. The continued degradation of critical habitat that would occur without the Army's conservation and stewardship programs is a major factor considered in our evaluation of the proposed action.

General Effects of Fire on Native Hawaiian Plants

Fire is a relatively new, human-related threat to native species and natural vegetation in Hawaii. The historical fire regime in Hawaii was characterized by infrequent, low severity fires (Cuddihy and Stone 1990; Smith and Tunison 1992). Few natural ignition sources existed, natural fuel beds were often discontinuous, and rainfall in many areas on most islands is moderate to high. Fires inadvertently and intentionally ignited by the original Polynesians in Hawaii probably contributed to the initial decline of native vegetation in the drier plains and foothills. These early settlers practiced slash-and-burn agriculture that created open lowland areas suitable for the later colonization of non-native, fire-adapted grasses (Kirch 1982; Cuddihy and Stone 1990). Beginning in the late 18th century, Europeans and Americans introduced plants and animals that further degraded native Hawaiian ecosystems. Pasturage and ranching, in particular, created highly fire-prone areas of non-native grasses and shrubs. Today, although fires are infrequent in mountainous regions, extensive fires have occurred in lowland mesic areas, and up to half of the areas dominated by alien species have been damaged by fire (D'Antonio and Vitousek 1992).

Fires of all intensities, seasons, and sources are destructive to native Hawaiian ecosystems (Brown and Smith 2000), and a single grass-fueled fire can kill most native trees and shrubs (D'Antonio and Vitousek 1992). Few native Hawaiian plants and animals are adapted to withstand fire, and none is known to depend on fire for its existence or regeneration. Consequently, most native plants and animals perish during fires with little recovery afterwards. In lowland communities, alien-dominated grasslands and shrublands constitute the greatest fire threat to native vegetation. Many non-native invasive plants, especially fire-tolerant grasses in dry areas, outcompete native plants and inhibit their regeneration (D'Antonio and Vitousek 1992; Tunison et al 2001; Tunison 2002). Successive fires that burn farther and farther into native forest destroy endangered plants and remove habitat for native species by altering canopy conditions to favor alien plants.

Alien plant species most likely to be spread as a consequence of fire are those that produce a high fuel load, are adapted to survive and regenerate after fire, and establish rapidly in newly burned areas. For example, a documented increase in the frequency and size of fires at Hawaii Volcanoes National Park since 1968 coincided with an increasing cover of alien grasses (Smith and Tunison 1992). The conversion of Makua to a military live-fire range in the 1940s introduced seed spread and a daily source of ignition (Beavers et al 1999). Currently, alien grasses such as guinea grass (*Panicum maximum*) and molasses grass (*Melinis minutiflora*) dominate the valley floor, C-Ridge, and the northern ridge of Makua.

Fire Stressors in the Makua Action Area

The Army's proposed action is likely to adversely affect listed plants, animals, and critical habitats that are exposed to training-related wildfire. This conclusion is supported by the Army's biological assessment (U.S. Army Garrison 1998) and draft environmental impact statement (U.S. Army Corps of Engineers 2005), the interagency Makua Implementation Plan (Makua Implementation Team 2003), the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a), Army status reports on implementation of the Makua Implementation Plan (U.S. Army Garrison 2004, 2005b), Army computer fire simulations (Beavers 2005), and additional Service fire modeling for this consultation. Stressors associated with training-related wildfire include flames, heat, smoke, and ash. In the action area, occurrences of listed plants and critical habitats will be exposed to these stressors within zones of high, low, and very low fire risk.

Fire Exposure Area

The Service's methodology for delineating the training-related wildfire threat in the action area is fully described in the section General Effects—Fire Suppression. The high, low, and very low fire risk zones are shown on Figure E 7.

The low fire risk zone is defined as the area where the misfired or malfunctioning long-range weapons systems and munitions can potentially ignite a fire, including endangered species occurrences on the upper slopes of the Makua Valley rim and beyond. In particular, long-range ignitions from Javelin anti-tank missiles, helicopter-launched 2.75-caliber rockets, and TOW missiles may ignite fires outside the firebreak roads. The exact location where listed resources will be exposed to any particular source of training-related wildfire is unpredictable. With the fire-fighting productivity improvements included as part of the proposed action, most fires are expected to be suppressed before they escape the firebreak roads and will not affect listed resources. However, there is a risk of fires igniting and spreading outside the firebreak roads, or spreading outside the firebreak roads from ignitions within the impact area, to areas where listed species are located. Therefore, we anticipate the Army will reduce but not eliminate the ignition and spread of training-related wildfire over the 30 years covered by this Biological Opinion.

Fire Timing, Duration, and Frequency

Depending on the season when fire occurs, any or all plant life stages (mature, immature, and seedling) will be exposed to fire stressors throughout the year. Potential fire risk is assessed by the National Fire Danger Rating System (NFDRS) and live fuel moisture conditions under which particular weapons systems and munitions may be used (see Table PD 2). The potential for fire ignition and spread is greatest when exercises are conducted in other than Green NFDRS conditions. According to Service analysis of fire weather conditions at Makua, In addition, any fire has the potential to spread outside the firebreak road if conditions change to Red before the fire is contained (see General Effects—Fire Suppression).

Once ignited, the duration of exposure of listed resources to fire is variable and depends on weather, wind speed and direction, fuel loadings, and the effectiveness of firefighting response. In general, past fires at Makua have burned anywhere from 30 minutes up to three days before being extinguished (U.S. Army Corps of Engineers 2005). Fire duration, and thus the extent of area that burns, is expected to be considerably reduced with the Army's proposed improvements in helicopter fire-bucket productivity (see General Effects—Fire Suppression). The frequency that listed resources will be exposed to training-related wildfire is unknown for the proposed action.

The Army will also conduct prescribed burns to help manage fuels within the training impact area. According to the prescription proposed as part of the proposed action, prescribed burns will only be conducted during tightly specified conditions of weather, wind, and live fuel moisture. The exposure area for prescribed burns will be within the training impact area inside the firebreak roads. The burn prescription covered by this Biological Opinion, including timing (season), duration, frequency, and intensity of prescribed burns, is described in Appendix D. The physical, chemical, and biotic features exposed to prescribed burns are the same as the general effects of fire described below. No listed resources will be exposed to properly managed prescribed burns.

Fire Intensity

Heat and flames are the stressors to which plants will be most directly exposed, and intensity of exposure will vary according to fire severity. A regime of high and low severity fires is characteristic in the mixed native and non-native vegetation types of Makua (U.S. Army Garrison 2003b) and throughout Hawaii (Brown and Smith 2000). In Hawaii, a high-severity fire is defined as a lethal (catastrophic) crown and/or surface fire fueled by non-native grasses that kills at least 80 percent of the dominant vegetation. A low severity fire is defined as a sub-lethal understory fire that does not substantially change the structure of the dominant vegetation and usually involves surface fires fueled by non-native grasses and forest litter in the understory or at the forest edge. In mixed forest types, lethal catastrophic fires carried by grass in the understory kill trees and facilitate grass encroachment farther inside the canopy of native forest types. The fire encroachment zone thus expands over time as a result of a series of lethal catastrophic fires, sub-lethal surface fires, or a combination of both. Also, with each successive fire, the growth of grass fuels encroaches farther into the forest. Thus, the expansion of this encroachment zone increases the risk of a catastrophic, stand replacement fire in mixed and native-dominated forest where non-native grasses have invaded the understory. Over time, such a fire regime creates a positive feedback cycle that changes a non-flammable, native-dominated woodland to a self-perpetuating, highly flammable, alien-dominated grassland (Hughes et al 1991; D'Antonio and Vitousek 1992; Smith and Tunison 1992; Freifelder et al 1998; Brown and Smith 2000; Tunison et al 2001; Brooks et al 2004; Hawaii Volcanoes National Park 2004).

Physical, Chemical, and Biotic Features Exposed to Fire

Within the exposure areas at Makua delineated by fire risk zones, habitat features essential to listed resources will be exposed to heat, flames, smoke, and ash (Brown and Smith 2000). Intensity and duration of exposure will depend on where the fire is ignited, local weather, topography, grass cover, and firefighting response. Physical features that will be exposed to heat and flames include soil structure and microclimate conditions. Fire will increase soil temperatures, alter soil moisture holding capacity, and reduce soil rainfall infiltration (Barbour et al 1987). These physical features will be indirectly exposed to post-fire erosion and alterations of light/shade, temperature, humidity, and wind as a result of vegetation destruction. Light levels, temperatures, and wind speeds will increase with destruction of canopy plants, and relative humidity will decrease. Alternatively, in burned areas that are invaded by dense mats of molasses grass, shading of the soil surface may reduce temperature and increase humidity (Tunison et al 2001). Soil erosion may occur after fire except where rapid establishment of alien grasses is prevalent (Hawaii Volcanoes National Park 2004). Chemical features that will be exposed to heat, flames, smoke, and ash include soil nutrients and water, which will be indirectly exposed to post-fire changes in content and cycling rates. Soil nutrient availability will be altered through volatilization of certain elements to the atmosphere in smoke (e.g., carbon, nitrogen, and sulfur), conversion to more available forms in the ash (e.g., potassium, phosphorus, and divalent cations), wind dispersal of the ash, and surface erosion (D'Antonio and Vitousek 1992; Waring and Running 1998; Tunison et al 2001).

Biotic features that will be exposed to heat, flames, smoke, and ash include all living organisms in the exposure area, litter layers on the forest floor, organic matter within the surface soil horizon, and seeds within the litter and surface soil. Living organisms will be directly exposed to injury or death, and seeds, litter, and organic matter will be directly exposed to destruction and loss (Kinnaird and O'Brien 1998; Van Nieuwstadt et al 2001). These effects in turn will indirectly expose soils to long-term changes in fertility and structure as a result of disrupted decomposition and nutrient cycling processes, reduced nutrient and water retention by organic matter, increased nutrient losses in runoff and leaching, and reduced ecosystem primary production due to loss of leaf area and photosynthesis (Kinnaird and O'Brien 1998). Mobile birds and animals are able to escape fire; relatively sedentary animals such as native tree snails and Oahu elepaio eggs and nestlings, however, will be exposed to fire injury and death. Woody vegetation injured by fire will become more susceptible to wood-boring and bark beetles, such as the black twig borer. All these factors will result, over time, in ecosystem changes to species composition and the relative abundance of native and non-native plants and animals, which in turn will alter post-fire patterns of vegetation development and succession.

Within the action area, the biotic features that will be exposed to fire includes various mixtures of native and non-native vegetation in dry and mesic forest, and native-dominated forest and shrubland (see Tables PD1 and PD2). In any habitat, the exposure of listed plants and critical habitats to fire will depend in large part on the density of alien grass cover within endangered plant occurrences, management units, and critical habitats. Some endangered species occurrences within the action area are directly adjacent to dense cover of alien grasses and shrubs.

Mesic forest conditions with closed canopies and sparse, understory grass cover typically slow the spread of fire, whereas dry conditions with open canopies and dense grass facilitate fire spread. Mesic forest is characterized by higher rainfall and humidity, which inhibit the drying of fuels in the understory and on the forest floor. In fact, undisturbed tropical rainforest was long thought to be virtually immune to fire (Whitmore 1990). Biologists now recognize that even rainforest conditions do not preclude the incidence of fire, especially during prolonged drought conditions. Extensive fires in the equatorial rainforests of Indonesia have occurred since the early 1980s, during five prolonged droughts associated with strong El Niño events (Kinnaird and O'Brien 1998; Uhl 1998; Van Nieuwstadt et al 2001). Although intact rainforest was impacted, about two-thirds of the thousands of square kilometers that burned had been previously selectively logged or otherwise disturbed. Most of the fires were low intensity ground fires ignited by small-scale, slash-and-burn agricultural activities and hunting/fishing campfires. In general, forest damage was not severe and was limited to the litter and understory, although subcanopy and canopy trees also died. Almost all trees less than 8 cm (3 in) in diameter measured at a height of 1.37 m (4.5 ft) died within one year after the 1997 to 1998 fires, and many surviving larger trees became increasingly susceptible to windthrow (Van Nieuwstadt et al 2001). Similar fire impacts occurred in selectively logged areas of the Amazon rainforest where gaps created by single-tree felling resulted in warmer, drier microclimate conditions and drier fuels (Uhl and Kauffman 1990). Thus, forest disturbance and prolonged drought may significantly increase the probability of fire in tropical rainforest (Uhl and Kauffman 1990; Kinnaird and O'Brien 1998; Uhl 1998; Mueller-Dombois 2001; Van Nieuwstadt et al 2001).

Drought is a significant problem in Hawaii, affecting parts of the state at least once every five years, with severe droughts occurring about every 15 years (Hawaii Commission on Water Resource Management 2005). Substantial variation in rainfall is caused in large part by the El Niño Southern Oscillation (ENSO) (Juvik and Juvik 1998; Hawaii Commission on Water Resource Management 2005). The ENSO phenomenon is a Pacific-wide warming of surface waters associated with persistent high-pressure atmospheric systems that generally occur every two to seven years and result in reduced rainfall in the Hawaiian Islands. About 20 severe droughts in Hawaii since 1905 were likely associated with ENSO, including recent record El Niño droughts during the winter and/or spring of 1982 to 1984, 1996, and 1997 to 2003 (Hawaii Commission on Water Resource Management 2005, Pacific Disaster Center 2006). In 1998, for example, mean rainfall on Oahu was only one-third of normal levels. Rainfall and climate in Hawaii are also influenced by the Pacific Decadal Oscillation, which causes long-term shifts of surface ocean temperatures in the North Pacific over periods of 30 to 40 years. Since the 1970s, the Pacific Decadal Oscillation has been in a warm phase and Hawaii rainfall has generally been below normal. According to the Hawaii Drought Plan, agriculture and environmental resources are generally considered vulnerable to drought in the Waianae and Makaha areas, respectively, of leeward Oahu (Hawaii Commission on Water Resource Management 2005).

Listed Resources That Will Be Exposed to Fire

In total, 38 listed plant taxa, host trees for Oahu tree snails, and nest trees and foraging habitat for the Oahu elepaio will be directly and indirectly exposed to fire within the action area. All life stages of native plants will be exposed to the risk of fire throughout the year, depending on season, although exposure will be reduced during the dry summer months when fire weather and live fuel moisture conditions preclude training with certain weapons systems and munitions. Exposure of reproductive stages (flowers/fruits, seedlings, eggs, etc.) will depend on the season in which fires occur. The reproductive stage of some plant species is seasonal whereas others produce flowers and fruits throughout the year. Oahu tree snails may breed throughout the year, and the Oahu elepaio nesting season is January through June. The number of individuals and occurrences of each species that will be exposed depends on the location, intensity, and duration of fire, as well as local weather, topography, grass cover, and firefighting response. Alien plant invasion in burned areas of critical habitat also will adversely affect native plants that comprise the vegetative primary constituent elements determined to be essential for the survival and recovery of listed plants and the Oahu elepaio. The number of individuals and occurrences of each species that will be exposed to fire at Makua is discussed in the species-specific effects analyses that follow this General Effects section.

Response of Endangered Plants to Fire

Direct Effects

The response of listed plants and associated native plants that will be directly exposed to fire includes both lethal and sub-lethal components. Lethal exposure will result in the death of individual plants (canopy and subcanopy trees, saplings, shrubs, understory herbs and grasses, and seedlings) or entire occurrences from destruction of vital tissues. Terrestrial plants require a minimum leaf area for photosynthesis and transpiration, roots for water and nutrient uptake, and stems for physical support and internal transport of water and nutrients. Without these physiological functions, plants cannot survive, grow, and reproduce. Plants are vulnerable to crown and surface fires, depending on their height. Above-ground parts of small plants are almost always killed, whereas tall shrubs and trees may survive crown scorch if some buds and cambium survive. Lethal heating of the cambium layer kills trees and shrubs. Fire resistance is related in part to thick bark, which is not characteristic of Hawaiian species. Sub-lethal exposure will result in injury to leaves, stems, exposed cambium, roots, growing tissues, buds, flowers, fruits, and seeds.

Indirect Effects

The response of listed plants and associated native plants to sub-lethal exposure to fire will result in decreased individual plant fitness due to physiological stress in fire-injured plants. Physiological stress associated with reduced leaf area will result in decreased photosynthesis and increased transpiration water stress. Loss of meristematic tissue on branches and stems temporarily halts plant growth and reproduction. Although root injury may directly kill trees and shrubs, it more commonly weakens them by increasing the physiological stress of reduced water and nutrient uptake capacity. The physiological stress resulting from these injuries will decrease overall vigor, growth, and fecundity of individual plants. The consequences of physiological stress on individual fitness will vary among individuals exposed to fire and will range from reduced growth and vigor, to reduced reproduction and recruitment, to delayed mortality. Post-fire plant mortality often results from injury to several plant parts, such as crown and cambium, and may not occur for several years. Fire-injured plants also are more likely to die from environmental stresses such as disease pathogens, fungi, insects, or drought (Brown and Smith 2000).

Non-injured plants, especially seedlings and saplings, will be more vulnerable to physiological stress due to post-fire microclimate changes and competition with invasive plants. The response to fire-altered habitat conditions and competition with alien grasses will differ for individual native plants. Little information is available on the specific responses of rare Hawaiian species to fire, but they may be generally inferred from the response of other native species and vegetation types, especially in relation to long-term successional patterns (Smith and Tunison 1992). For example, the loss of dry forest habitat in Hawaii, caused in large part by humans, is believed to have contributed to the extinction of endemic plant and animal species (Cuddihy and Stone 1990).

A major indirect effect of the loss of native vegetation from fire is the reduced availability of suitable habitat for regeneration of native plants. Fire changes the relative composition and abundance of native and non-native plant and animal species, as well as future patterns of vegetation development and succession. Loss or reduction of canopy vegetation reduces shade and creates ambient temperature, humidity, and wind conditions unfavorable to plants accustomed to more mesic or understory sites. Most native Hawaiian plants do not resprout or regenerate from buried seeds after a fire has passed. Whether listed species in the action area resprout or regenerate from buried seeds after fire is unknown, but they are probably similar to most native Hawaiian plants in lack of resistance or tolerance to fire. The non-native grass species at Makua are typical of open, dry habitats that result after fire. Increased cover of faster-growing, fire-resistant, non-native grasses in and adjacent to burned areas will reduce the availability of growing space, light, water, and nutrients for native plants of all stages. Competition for these resources will exacerbate physiological stress, especially in any fire-injured plants that survive. In addition, if fence exclosures are destroyed or damaged by fire, survival and regeneration of listed plants will be constrained by post-fire effects of soil disturbance and compaction, root injury, and trampling by feral ungulates. Ungulates and rats escaping from fire are likely to increase in numbers adjacent to burned areas.

Most importantly, invasion by non-native, fire-adapted grasses will alter fuel load and fire hazard in burned areas. In Hawaii, non-native grasses quickly resprout within weeks after fire and can attain pre-burn cover densities in 18 to 24 months, converting seasonally dry woodlands into savannas of scattered trees (Mueller-Dombois and Goldammer 1990; Hughes et al 1991; D'Antonio and Vitousek 1992; Tunison et al 1992, D'Antonio et al 1998; Tunison et al 2001; Hawaii Volcanoes National Park 2004). The Service infers from these documented examples that training-related wildfire will similarly favor the invasions of alien grasses and reduce the persistence probability of listed species in the Makua action area. The overall effect of indirect exposure of listed plants to fire will be reduced reproductive fitness and recruitment of individuals, a further decline in numbers, and reduced viability of population units.

General Effects of Non-Native Invasive Species

All 49 taxa and/or critical habitats covered by this Biological Opinion are variously threatened by non-native invasive plants, animals, and invertebrates (Appendix E). After habitat loss, alien species are the second-greatest threat to imperiled species in the United States (Wilcove et al 1998). In Hawaii, non-native feral ungulates and invasive plants are the two most serious threats to native habitats (Cuddihy and Stone 1990). As of the early 1990s, over 4,600 alien species had been introduced to Hawaii, of which 86 are recognized as serious threats (Scrowcroft and Conrad 1992).

Non-Native Ungulates

It has long been known that feral ungulates are important causes of native vegetation decline in Hawaii. Native flora evolved in absence of mammalian grazers and most native woody plants lack defenses against grazing (Cuddihy and Stone 1990). Long-term damage by ungulates can eliminate native plants and deplete soil seed banks; alter habitat microclimate, water balance, and nutrient cycling processes; and increase vulnerability of native plants to insect attacks (Stone et al 1992). Two species of feral ungulates, pigs (*Sus scrofa*) and goats (*Capra hircus*), are present throughout parts of the action area. Feral pigs and goats damage a wide elevational range of wet, mesic, and dry native ecosystems in Hawaii (Stone et al 1992). Both pigs and goats spread alien plants into native habitats by transporting seeds in their feces and fur, and by creating areas of bare soil and open canopy for alien plants to become established and spread (Stone 1985; Cuddihy and Stone 1990; Stone et al 1992). Both pigs and goats are naturalized in Hawaii and are managed as game animals, but they may inhabit inaccessible areas where hunting has little effect on their numbers (Service 1998a).

Feral pigs have been in the Koolau and Waianae Mountains of Oahu for about 150 years, and goats were introduced in the Waianae Mountains in the early 1820s (Cuddihy and Stone 1990; Service 1998). Pigs eat both plant and animal material, including native ferns, tree ferns, lilies, mints, lobelioids, koa seedlings, and other woody plants. Pigs also uproot and trample vegetation, and expose earth by rooting soil for earthworms, rhizomes, and tubers (Stone 1985). The last known population of three *Cyanea truncata* plants in windward Oahu was destroyed in recent years by feral pigs (Service 1998). Pigs also are known dispersal agents for habitat-altering, non-native plants such as *Psidium cattleianum* (strawberry guava), *Passiflora tarminiana* (banana poka), *Schinus terebinthifolius* (Christmas berry), and *Rubus argutus* (blackberry), which threaten several taxa in the action area (Stone 1985; Cuddihy and Stone 1990). Feral goats browse on native and non-native plants, especially in dry, open ecosystems. Goats also trample roots and seedlings, increase erosion and watershed degradation by removing plant cover and trampling soil, and promote the invasion of alien plants (Service 1998). Goat damage to native vegetation has permanently altered some native ecosystems on Oahu (Cuddihy and Stone 1990).

In the Makua action area, grazing and trampling by feral pigs and goats have degraded extensive tracts of native vegetation, impacted habitats of listed species and critical habitats, and directly injured listed plants. In the action area and generally, pigs prefer moister areas, whereas goats prefer drier, steeper areas. Of the eight management units located entirely or partially within the action area, three are fenced (Kaluakauila, Lower Ohikilolo, and Pahole), two are partially fenced (Kahanahaiki and Ohikilolo), and three are not fenced to exclude ungulates (Upper Kapuna, West Makaleha, and Keaau-and-Makaha). Army Natural Resources Staff believe goats have been virtually eradicated from all of Makua (although not from the entire action area). As long as fences are maintained and ungulate sign is monitored, exclosures are effective in protecting native habitats from ungulate damage. However, fences are occasionally damaged by rockslides, and fire (such as the July 2003 prescribed burn, and the July 2006 non-military fires) can damage the galvanized anti-corrosion coating of wire mesh, facilitating future breaches (U.S. Army Garrison 2005b, 2006a, 2006b).

The fenced management units are generally considered ungulate-free (U.S. Army Garrison 2005b). The fenced Kaluakauila Management Unit is still accessed occasionally by pigs, particularly during the strawberry guava fruiting season. The partially fenced Ohikilolo Management Unit is protected by a perimeter fence at the installation boundary with

Ohikilolo Ranch and the Keaau Game Management Area, both of which support large populations of feral goats. Goats have contributed to serious erosion problems on Ohikilolo Ridge. As a result of Army removal efforts, monitoring results since 2004 indicate that goats have been eradicated from the Ohikilolo Management Unit. In addition, over a hundred pigs and goats have been removed from the unfenced Kahanahaiki Sub-Unit II Management Unit and adjacent areas since 1998. Ungulate numbers in this subunit seem to increase during the winter-spring breeding season and during the August dog-hunting season in adjacent state public hunting areas. The other unfenced management units are located on State lands where Army staff is not involved in active ungulate management.

Non-Native Rodents

Several small rodent species are found in the Makua action area, including rats (*Rattus* spp.) and mice *(Mus domesticus*). These rodents occur on all the main Hawaiian Islands around human habitations, in cultivated fields, and in dry, mesic, and wet forests. Rats eat the fruit and strip the bark of some native plants, particularly fruits of native *Pritchardia* palms and plants in the lobelia (Campanulaceae) and African violet (Gesneriaceae) families with fleshy stems and fruits (Cuddihy and Stone 1990). Many native Hawaiian plants produce their fruits or seeds over an extended period, providing a prolonged food supply that supports rodent populations. Rats are suspected predators of about half of the 49 species covered in this Biological Opinion, including plants, Oahu tree snails, and Oahu elepaio.

Non-Native Invertebrates

Major non-native invertebrate pests in the Makua action area include slugs (such as *Deroceras reticulatum*), carnivorous snail (*Euglandina rosea*), black twig borer (*Xylosandrus compactus*), Chinese rose beetle (*Adoretus sinicus*), two-spotted leafhopper (*Sophonia rufofascia*), and mosquito (*Culex quinquefasciatus*). Army activities are unlikely to directly increase the spread of these invertebrate pests. However, invertebrate pests constrain the Army's ability to maintain baseline numbers and stabilize certain target species. In addition, training-related wildfire may indirectly predispose individual plants to infestation through fire injuries and habitat alteration. Physiological stress in fire-injured plants increases susceptibility to pests and pathogens, especially during excessively dry or wet conditions (Brown and Smith 2000). Invertebrate pests are particularly threatening to listed species because specific management tools for use in forests and natural areas are currently unavailable. In particular, systemic insecticides applied to individual plants to control alien insect pests are unsuitable because they also are likely to injure or kill native insects.

Slugs are widespread in Hawaii and a serious threat to many native plants (Howarth 1985). The common slug on Oahu, *Vaginulus plebeius,* was introduced accidentally from South America and the Caribbean in the 1970s (Staples and Cowie 2001). Slugs are major horticultural and agricultural pests of seedlings and non-woody plants, and are common in residential landscapes as well as in mesic to wet forests. They are particularly active at night and in wet weather. Slugs feed on plants with fleshy leaves, stems, and fruits, including all taxa in the lobelia family in Hawaii and many taxa in the Hawaiian endemic genus *Schiedea* (Service 1998; U.S. Army Garrison 2005b). Slugs currently are an uncontrollable threat to the successful stabilization of several plant taxa in the Makua action area, including *Cyanea grimesiana* ssp. *obatae*, *Cyanea longiflora*, *Cyanea superba* ssp. *superba*, *Plantago princeps* var. *princeps*, *Schiedea kaalae*, *S. nuttallii*, and *S. obovata*. Slugs have been shown to reduce survival of *Cyanea angustifolia* seedlings by as much as 80 percent (see discussion in U.S. Army Garrison 2006d). Recent research funded by the Army has shown that mortality of *S. obovata* seedlings doubled within a month of outplanting when exposed to slug herbivory (U.S. Army Garrison 2005b). However, slug exclusion significantly enhanced survival of *S. obovata* and *C. superba* ssp. *superba* (U.S. Army Garrison 2006d). Slugs are particularly threatening to vulnerable native plants because no cost-effective control method has yet proved effective in forest conditions. Commonly used garden methods such as beer traps and copper barriers have mixed success and can only be used on a small scale (about a square meter (10.7 square feet). Currently no chemical control for mollusks are registered for forest or conservation use, especially where native snails may be present. The Army will fund research on the basic biology and ecology of slugs, including distribution, species composition, population density, seasonality of activity, and feeding habits (U.S. Army Garrison 2006d).

The carnivorous snail *Euglandina rosea* is a significant predator on native land snails, including *Achatinella mustelina,* and a major factor in their decline and extinction (Hadfield 1986; S. Miller, Service, pers. comm. 1988; Staples and Cowie 2001). *Euglandina rosea* was intentionally introduced from the southeastern United States for biocontrol of the non-native giant African snail (*Achatina fulica*), a major crop pest, for which it proved unsuccessful (Staples and Cowie 2001). *Euglandina rosea* is widespread in damp habitats, including residential landscapes and disturbed and native forests. It is generally found on the ground but can climb trees. Two snail exclosures with solid metal walls, salt troughs, and electrical barriers have been constructed in the action area, and appear to be excluding *Euglandina* (although *Euglandina* have been found within the Pahole exclosure in the past). At times, however, *Achatinella mustelina* also have been found in the salt troughs, and the electrical barriers often do not function properly (U.S. Army Garrison 2005b). *Euglandina rosea* is particularly threatening to Oahu tree snails because no cost-effective control method has yet proved effective in forest conditions.

The black twig borer was accidentally introduced from Japan and Singapore in 1931 and now inhabits dry, mesic, and wet forests throughout most of Hawaii (Staples and Cowie 2001). It is a tiny beetle that attacks over 100 species of trees and shrubs by burrowing into woody branches, where it lays its eggs and introduces a pathogenic fungus as food for its larvae. The fungus is responsible for decline or death of twigs, branches, and entire plants. In Hawaii, the black twig borer has many native and non-native plant hosts, disperses easily, and probably occurs at most elevations up to 670 m (2,500 ft) (Howarth 1985). In the action area, black twig borers are a major threat to *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea,* and may be a threat to *Schiedea nuttallii* (Service 1998b; U.S. Army Garrison 2004). Several parasitoids have been introduced to control this beetle, but have not become established. Further research on biological control proceeds cautiously as several rare, native scolytid beetles are closely related to the black twig borer and could be impacted by control measures (Service 1998).

The Chinese rose beetle was accidentally introduced from Japan and Taiwan in the late 1800s and is now a common pest of shrubs and plants. It is usually found in lowland areas and occasionally up to elevations of 1,220 m (4,000 ft) (Staples and Cowie 2001). Known hosts for this beetle include over 250 species of ornamental and cultivated plants, and its presence is increasing in native habitats. These beetles feed at night on plant tissue between leaf veins, creating a “lace-like” appearance, which reduces the plant’s photosynthetic capability and vigor and increases its vulnerability to disease pathogens. In severe cases, most leaves are skeletonized and the plant may die (Staples and Cowie 2001; Mau and Kessing 2004). Chinese rose beetles cause major damage to hibiscus plants in Hawaii, including *Hibiscus brackenridgei* ssp. *mokuleianus* in some of the wetter *in situ* sites where it has been planted in the Makua action area.

The two-spotted leafhopper, a recent accidental introduction from China, causes mechanical damage on leaves, typically in the form of stippling and yellowing. Damage from sap-sucking or egg-laying reduces the plant’s photosynthetic capability and vigor, and may result in dieback of plant parts or death of the entire plant. In feeding, this insect also may introduce a plant virus or toxin. The two-spotted leafhopper has been found to cause economic damage to crops and ornamental plants in Hawaii, including over 250 species of native and non-native plants, from sea level to elevations of about 1,220 m (4,000 ft) (Staples and Cowie 2001). Although the two-spotted leafhopper is not known to threaten listed species in the action area, it is suspected of causing severe dieback of the native fern *Dicranopteris linearis* and may threaten this and other native plants in the surrounding ecosystem (Service 1998).

Five non-native species of biting mosquitoes that prey on warm-blooded vertebrates have been present in Hawaii since the early 1800s, beginning with the accidental introduction of *Culex quinquefasciatus* in the water casks of whaling ships (Staples and Cowie 2001). Mosquitoes carry avian malaria parasites (*Plasmodium rilictum*) and avian pox virus (*Avipox* spp.). These disease pathogens have contributed to the decline and extinction of native forest birds and may infect the Oahu elepaio (Service 2003b). These nocturnal insects inhabit wet areas of residential, rural, and forested areas from sea level to about 1,500 m (4,900 ft).

Exposure Area: Non-Native Animals

Stressors associated with the introduction and spread of non-native invasive animals include trampling and uprooting of native plants, grazing and browsing, and erosion caused by feral ungulates; seed/fruit predation by rats and mice; and tree snail and elepaio predation by rats. Stressors associated with the introduction and spread of non-native invasive invertebrates include herbivory, seed/fruit predation, tree snail predation, and transfer of plant and avian pathogens. The area exposed to these effects includes various locations throughout the action area, wherever these pests are not excluded or controlled. Because invasive animals and invertebrates are already present throughout the action area and on adjacent lands throughout Oahu, if uncontrolled, they will increase and spread in the action area without new introductions. Most feral pigs and goats, for example, have been removed from fenced exclosures, and goats have been virtually eliminated from Makua (U.S. Army Garrison 2005b). Pigs and goats are not excluded from many non-Army lands outside the installation.

Non-native carnivorous snails are excluded only from the Kahanahaiki and Pahole snail exclosures. Rats are controlled at the snail exclosures, in various plant stabilization population units, and at Oahu elepaio nesting sites. Other invertebrates such as snails and insects occasionally may be controlled in some areas.

Timing, Frequency, Duration, and Intensity: Exposure to Non-Native Animals

The timing and frequency at which listed resources will be exposed to non-native invasive animals and invertebrates are continual and ongoing throughout the year. The frequency of fire also will affect the movements of feral ungulates and rats out of burned sites into adjacent escape areas that contain listed resources. The intensity of exposure depends on existing population levels of alien species and the effectiveness of Army control efforts. The duration of stressors associated with alien species is permanent, unless and until they can be totally eradicated and controlled in the action area and throughout Hawaii.

Physical, Chemical, and Biotic Features Exposed to Non-Native Animals

Within areas exposed to non-native animals and invertebrates, listed resources will be directly exposed to trampling, erosion, predation, herbivory, and infestation by feral ungulates, rodents, invertebrates, and pathogens. Physical features that will be directly exposed to trampling and erosion include soil texture and bulk density, which influence soil loss and compaction rates. Biotic features that will be directly exposed include all living organisms, litter layers on the forest floor, and organic matter within the surface soil layer. Living organisms will be directly exposed to injury and death, and litter layers and organic matter will be indirectly exposed to erosion and loss. Loss of these biotic features will result in changes to species composition and the relative abundance of native and non-native plants.

Listed Resources Exposed to Non-Native Animals

All life stages of listed species and primary constituent elements of critical habitat will be exposed to stressors from invasive species throughout the year. Some plants may be more vulnerable to or less able to recover from predation by invertebrates and rats, or infestations of insects and slugs, during reproductive, seedling, and immature stages. Some plants may be more vulnerable if already stressed by fire injuries, fire-altered or drought-affected habitats, or excessively wet conditions. Depending on their reproductive cycle, all life stages of native plants and animals will be exposed to invasive species throughout the year. In addition, essential habitat features such as tree-snail host trees, elepaio nest trees, and primary constituent elements of critical habitat (including topography, soil substrates, microclimate, and native plant associates) will be exposed to invasive animals and invertebrates. The number of individuals of listed species that will be exposed depends on the local population levels of invasive species and Army control efforts, and are discussed in the species-specific effects analyses that follow.

Response of Listed Resources to Non-Native Animals

Direct Effects

The response of listed resources that will be directly exposed to non-native animals and invertebrates includes both lethal and sub-lethal components. Lethal exposure will result in the death of individual plants from grazing, trampling, or uprooting by feral ungulates, and from herbivory by insects and slugs. Terrestrial plants require a minimum leaf area for photosynthesis and transpiration, roots for water and nutrient uptake, and stems for physical support and internal transport of water and nutrients. Without these physiological functions, plants cannot survive, grow, and reproduce. Sub-lethal exposure will result in injury to leaves, stems, roots, growing tissues, buds, flowers, fruits, and seeds from ungulate trampling and grazing, herbivory by slugs and insects, and seed and fruit predation by rodents and insects. Oahu tree snails will be directly exposed to injury or death by rat and *Euglandina rosea* predation, and Oahu elepaio will be directly exposed to injury or death by rat predation of nestlings and eggs.

Indirect Effects

The sub-lethal response of listed resources to direct and indirect exposure to invasive mammals and invertebrates will result in diminished individual plant fitness due to physiological stress in injured or diseased plants. These effects are similar to those described above in General Effects of Fire on Native Hawaiian Plants. Physiological stress due from loss of leaf area results in decreased photosynthesis and increased transpiration water stress. Damaged root systems and those in compacted or eroded soils have reduced water and nutrient uptake capacity, and loss of meristematic tissue on branches and stems temporarily halts plant growth and reproduction. The physiological stress resulting from these injuries will reduce overall vigor, growth, and fecundity of individual plants. The consequences of physiological stress on individual plant fitness will vary among individuals exposed to invasive species, and will range from reduced growth and vigor, to reduced reproduction and recruitment, to delayed mortality. Moreover, fire-injured plants are more likely to die from environmental stresses such as disease pathogens, fungi, or insects. The overall effect of invasive mammals and invertebrates on listed resources will be reduced individual fitness and a further decline in numbers and population viability.

A major indirect effect of the loss of native vegetation due to non-native invasive mammals and invertebrates is the reduced availability of suitable habitat for regeneration of native plants. By inducing changes in the relative composition and abundance of native and non-native species, invasive mammals and invertebrates also alter future patterns of vegetation development and succession. Pigs and goats are known dispersal agents for habitat-altering, non-native plants; they also increase erosion and watershed degradation by removing plant cover and trampling soil. Long-term damage by feral ungulates results in simplification of native vegetation types and the continued presence and spread of alien plants (Stone et al 1992). The Service infers from documented examples of ecosystem effects of invasive species on native Hawaiian vegetation that introduction and spread of non-native animals will similarly reduce the persistence probability of listed species in the Makua action area (Cuddihy and Stone 1990; Stone and Tunison 1992; Stone et al 1992; Cabin et al 2000).

Non-Native Plants in the Makua Action Area

All 49 listed taxa and/or critical habitats covered by this Biological Opinion are threatened by competition with non-native invasive plants (see Appendix E). An increase in resource availability (light, nutrients, and water) is likely a key factor controlling the susceptibility of natural communities to invasion by alien species (Davis et al 2000). Resource availability increases when uptake by existing plants declines because of death or injury from fire, ungulates, invertebrate pests, and disease. According to a review of 150 published, peer-reviewed studies, however, research results on the "invasibility" of natural communities by non-native species have been inconsistent and the long-term mechanisms that underlie competition mechanisms are poorly understood (Levine et al 2003; Gurevitch and Padilla 2004).

According to Gurevitch and Padilla (2004), examination of the International Union for Conservation of Nature and Natural Resource's IUCN "Red List" data of worldwide threatened species reveals that only four percent of U.S. plant species (e.g., *Xylosma crenatum* on the island of Kauai) and two percent of plant species worldwide are threatened solely by invasive plants, and not also by cattle, pigs, goats, or direct habitat alteration. In most cases, the correlation between alien plant invasions and native plant extinctions is due to limited observation and is supported by few causation studies. Thus, research so far has not determined whether alien plant species cause the decline of native plants, or whether alien invasions and native declines both result from habitat alteration. Even if competition with invasive plants is not in itself a cause for decline of native species, non-native plants do alter vulnerable native ecosystems through changes in primary production, decomposition, water balance, soil fertility, nutrient cycling, carbon storage, allelopathy, and disturbance regimes (e.g., fire, hydrology) (Vitousek 1992; Mack et al 2001; Levine et al 2003).

In general, invasive plants affect Hawaiian ecosystems primarily through impacts to resource availability, disturbance frequency and intensity, and interactions with agents of disturbance such as fire, animals, or disease (Smith 1985; Cuddihy and Stone 1990; Vitousek 1992). Alien grasses in dry habitats in Hawaii, for example, outcompete native woody plants because the dense, near-surface roots of grasses reduce the availability of soil nutrients and water for deeper-rooted woody plants (D'Antonio et al 1998). The competitive superiority of alien grasses usually is not apparent, however, without a causative disturbance such as fire. The most severe impact of alien species to community structure occurs through alteration of the natural fire regime, which results in conversion of native vegetation to alien grassland (see General Effects of Fire on Native Hawaiian Plants) (Vitousek 1992; Levine et al 2003). Dense cover of several fire-tolerant, alien grass species, including molasses grass and guinea grass at Makua, prevents seedling germination, growth, and reproduction of native plants, and facilitates the spread of fire into native dry and mesic woodlands (Cuddihy and Stone 1990; Hughes and Tunison 1991; Smith and Tunison 1992).

Environmental disturbances favor invasion by non-native plants through physical disruption and exposure of the soil surface to increased sunlight and ambient temperatures. These altered microclimate conditions can result in increased nitrogen mineralization, soil nitrate levels, nitrogen cycling rates, and carbon storage (Vitousek 1992; D'Antonio et al 1998; Mack et al 2001; D'Antonio and Meyerson 2002; Levine et al 2003). Such conditions generally benefit fast-growing species in open habitats, especially those with large, persistent soil seedbanks (D'Antonio and Meyerson 2002). The positive feedback cycle between alien grasses and fire frequency has altered soil nitrogen cycling through the loss of nitrogen accumulation, uptake, and litterfall provided by the native species that have been destroyed by fire (Mack et al 2001). Experimental removal of the non-native bunchgrass, *Schizachyrium condensatum,* from a seasonally dry woodland on the island of Hawaii, for example, has shown that grasses adversely affect growth and recruitment of native shrubs, even in the absence of fire, through soil nitrogen depletion and shading (D'Antonio et al 1998). In general, grass removal results in higher seedling density of all shrub species (D'Antonio et al 1998).

Some of the major invasive plants on leeward Oahu (and in the Makua action area) include Christmas berry (*Schinus terebinthifolius*), strawberry guava (*Psidium cattleianum*), koa haole (*Leucaena leucocephala*), Florida prickly blackberry (*Rubus argutus*), silk oak (*Grevillea robusta*), molasses grass (*Melinis minutifolius*), and guinea grass (*Panicum maximum*) (Service 1998). Christmas berry, a tree, and strawberry guava, a small tree or shrub, were introduced from tropical America and are now naturalized in disturbed mesic and wet forest habitats on most of the main Hawaiian Islands. Both produce large numbers of fruits that are dispersed by feral pigs and fruit-eating birds, and form dense stands that shade out and displace native plants. In addition, both may have allelopathic effects that inhibit the germination and growth of other species (Service 1998; Staples and Cowie 2001). The Australian silk oak tree was planted extensively in Hawaii for watershed reforestation. It is now naturalized in dry and mesic forests and disturbed areas on most of the main islands. Koa haole is an aggressive, naturalized nitrogen-fixing shrub or small tree from Central America. It dominates many low-elevation, dry, disturbed areas on all of the main Hawaiian Islands. Prickly Florida blackberry forms dense, impenetrable thickets in openings of mesic and wet forests where its fruits have been dispersed by birds. Molasses grass and guinea grass are perennial grasses introduced for cattle fodder that are now naturalized in disturbed, dry and mesic areas throughout most of the main Hawaiian Islands. Other invasive plants present in the Makua action area are described in the Makua Implementation Plan (Makua Implementation Team 2003) and the Army's status reports (e.g., U.S. Army Garrison 2005b). Appendix 3.1 of the Makua Implementation Plan lists 82 species of non-native priority weeds for control in selected stabilization management units.

Exposure Area: Non-Native Plants

Stressors associated with the introduction and spread of non-native invasive plants involve the establishment of grasses, broadleaf weeds, shrubs, and trees that displace native plants through alteration of microclimate and competition for growing space, water, and nutrients. The entire action area is vulnerable to the introduction and spread of non-native plants, which are prevalent within and adjacent to high-disturbance areas such as military training facilities.

Potential sources of non-native plant introduction into the Makua action area include mounted and dismounted maneuvers; movement of equipment, vehicles, and troops; and range maintenance and natural resource conservation activities. Troop movements into Hawaii from other states and countries, and from other installations in Hawaii and on Oahu, increase the likelihood that habitat-altering weeds will be introduced and spread into native habitats in the action area. For example, new invasive weeds at Makua were recently introduced from Pohakuloa Training Area on the island of Hawaii (U.S. Army Garrison 2005b).

Timing, Frequency, Duration, and Intensity: Exposure to Non-Native Plants

The timing and frequency at which listed resources will be exposed to the introduction and spread of non-native invasive plants are both continual and ongoing throughout the year whenever personnel, vehicles, and equipment enter the action area. Military training is expected to take place over 242 days each year, including up to 50 CALFEXs per year. In addition, managers and maintenance staff are on-site almost daily throughout the work week. Alien plants are ubiquitous throughout the Hawaiian Islands and comprise the majority of plants in developed coastal and lowland areas of Oahu. Therefore, weed seeds will be introduced and spread at Makua throughout the year via transport in vehicles, tire treads, equipment, clothing, backpacks, boots, and other gear. Non-native invasive plants also will be spread by pollination and seed dispersal from areas on Makua and Oahu where they have already become established. The timing and frequency of invasive plant introduction and spread will also be influenced by the frequency of fire (which will create openings for seed germination and establishment) and the movements of feral ungulates (which will create openings and disperse seeds). The duration of impacts associated with non-native plants is permanent, unless and until they can be totally eradicated and controlled in the action area and throughout Hawaii.

The intensity of stressors introduced and spread with invasive plants will depend on the level of traffic in personnel, vehicles, and equipment entering Makua. Convoy and ammunition transport vehicles arrive at Makua from Schofield Barracks, Wheeler Army Airfield, and Lualualei Naval Magazine on Oahu. Troops and equipment are also airlifted to Makua from Wheeler. Up to 62 ground vehicles will arrive at Makua for each CALFEX, including HMMWVs and trailers, Strykers, cargo trucks, flatbed trucks, tractors, forklift, and passenger vans and buses; a small bobcat loader and two HMMWVs equipped as fire trucks are assigned on-site (U.S. Army Corps of Engineers 2005). In addition, ITAM crews and other on-site staff arrive daily throughout the work week in personal vehicles from various locations on Oahu. The intensity of weed introduction and spread also depends on the effectiveness of Army phytosanitation measures to clean vehicles, equipment, and personal gear before entry into the action area; existing levels of alien plants available to spread into burned areas and other forest openings; and the effectiveness of Army efforts to control non-native ungulates and plants.

Physical, Chemical, and Biotic Features Exposed to Non-Native Plants

Listed resources will be indirectly exposed to stressors associated with microclimate changes and competition wherever sparsely vegetated areas offer seed germination beds for invasive plants. Seedbeds will be created by disturbances associated with military ground activities (such as munitions explosions, foot trampling, vehicle ruts, etc.), training-related wildfire, and grazing and movements of feral ungulates. These soil disturbances also will stimulate germination of alien seeds in soil seedbanks, which likely are plentiful in the action area. All plants require light, oxygen, carbon dioxide, water, and mineral nutrients to survive, grow, and reproduce. Terrestrial plants also require a substrate for rooting and establishment, such as bare soil, boulders, downed woody debris, or other plants. Physical features exposed to invasive plants include seed germination substrates and microclimate conditions (light/shade, temperature, humidity, wind), which will change after establishment of alien plant cover. Chemical features include soil nutrient and moisture levels that will change with alterations in the relative abundance of alien and native plants. Biotic features include all life forms, litter layers on the forest floor, and soil organic matter.

Listed Resources Exposed to Non-Native Plants

All life stages of listed plant species, and all native plant associates that are primary constituent elements of critical habitat, will be indirectly exposed to habitat alterations resulting from the introduction and spread of invasive plants. Native plants that provide essential habitat features include host trees for Oahu tree snails and nesting and foraging habitat for Oahu elepaio. Alien plant invasion in critical habitat also will adversely affect native plants that comprise the vegetative primary constituent elements determined to be essential for the survival and recovery of listed plants and the Oahu elepaio. The number of individuals and occurrences of listed resources that will be exposed depends on local population levels of invasive plants and Army control efforts, and are discussed in the species-specific effects analyses that follow.

Response of Listed Resources to Introduction and Spread of Non-Native Plants

The response of listed resources to indirect exposure to invasive plants involves diminished individual plant fitness due to physiological stress. Dense cover of alien grasses, shrubs, and trees will increase shade and create ambient temperatures unfavorable to seed germination and establishment of many native plants. Plants are generally more vulnerable to unfavorable microclimate conditions and competition during the seed germination and seedling establishment stages. In addition, physiological stress at any life stage may increase a plant's vulnerability to fire injury, grazing, insect infestation, drought, or excessively wet conditions. The consequences of physiological stress on individual fitness will vary among individuals exposed to invasive species, and will range from reduced growth and vigor to reduced reproduction and recruitment.

In addition, a major indirect effect of invasive plant competition is the reduced availability of suitable habitat for regeneration of native plants. Species differ in their response to environmental changes owing to differences in transpiration rates, leaf area, rooting depth, and phenology (flowering and fruiting seasons). These differences allow invasive species to exploit conditions unfavorable to native plants and alter future patterns of vegetation development and succession. Habitat resources associated with these features will become less available to native plants as the cover and density of invasive plants increase. In general, native communities and long-term patterns of vegetation development and succession will change as non-native plants increasingly displace native species. From documented examples of long-term ecosystem and succession effects of invasive species on native Hawaiian vegetation (Cuddihy and Stone 1990; Smith and Tunison 1992; D'Antonio et al 1998; Mack et al 2001; Cabin et al 2000, 2002a, 2002b), the Service infers that introduction and spread of non-native plants will similarly reduce the persistence probability of listed species in the Makua action area. The overall effect of indirect exposure of listed resources to invasive plants will be reduced reproductive fitness and recruitment of individuals, and a further decline in numbers and population viability.

General Effects of Human Disturbance

<u>Physical Disturbance Stressors in the Makua Action Area</u>

Listed resources will be exposed to physical disturbance associated with personnel movements in vegetated areas, including trampling and breakage of vegetation, trampling of soils, and dislodgment and crushing of tree snails. These impacts will occur during troop marches and other ground maneuvers by military personnel; construction and maintenance of firebreaks, fuels modification areas, and fences; and conservation management and monitoring activities. In particular, troop marches will increase the level of human activity along trails and access roads already established throughout parts of the action area (U.S. Army Corps of Engineers 2005). Army standard operating procedures to minimize the impacts of ground maneuvers include smoking bans for all personnel along trails and troop briefings regarding the need to avoid off-trail activities in sensitive areas.

Physical Disturbance Exposure Area

The northern ridgeline of Makua, including portions of Kuaokala Access Road and Trail, will be exposed to physical disturbance during troop marches. Kuaokala Access Road is a steep paved road to an old Nike missile site now used as an endangered plant nursery. The surrounding area supports a variety of common native plants and habitats, as well as non-native and mixed vegetation types (U.S. Army Corps of Engineers 2005).

Fences will be constructed and maintained around endangered species management units and in some cases around species-specific population units. Existing fences within the action area are maintained at the Kaluakauila, Kahanahaiki subunit I, Pahole, Ohikilolo, and Lower Ohikilolo management units. New fences in the action area will be constructed and maintained at the Kahanahaiki subunit II, Upper Kapuna, West Makaleha, Ohikilolo (Lower Makua), and Makaha management units (see Stabilization section of Project Description). Endangered species population units are managed and monitored by Army Natural Resources staff in population units accessed by foot trails (see General Effects of Endangered Species Stabilization, page 54 of this chapter). Firebreaks and fuel modification areas will be constructed and maintained by clearing vegetation (manually and/or by herbicide) around the firebreak roads, and below the Kaluakauila, Kahanahaiki, C-Ridge area, Okikilolo, and Lower Ohikilolo management units (see General Effects—Fire Suppression).

Timing, Duration, Frequency, and Intensity of Physical Disturbance

A maximum 150-Soldier company will march once a month on the Kuaokala Trail, at any time of day or night (U.S. Army Corps of Engineers 2005). Troop marches will add a maximum 1,800 people per year using Kuaokala Trail.

Physical, Chemical, and Biotic Features Exposed to Physical Disturbance

Physical features that will be directly exposed to physical disturbance by people include soil texture and bulk density characteristics. Biotic features that will be directly exposed to physical disturbance include all living organisms, litter layers, and soil organic matter. Litter layers and organic matter will be indirectly exposed to erosion and loss, which in turn affect chemical features such as soil fertility and moisture holding capacity.

Listed Resources Exposed to Physical Disturbance

Listed resources will be directly exposed to physical disturbance by humans passing on foot through vegetated areas, including stressors associated with trampling and breakage of vegetation, trampling and disruption of soils, and dislodgment and crushing of tree snails. Essential habitat features such as tree-snail host trees, elepaio nest trees, and primary constituent elements of critical habitat (including soil substrates and native plant associates) also will be exposed to trampling and breakage by people. Depending on their reproductive cycle, all life stages of listed species and primary constituent elements of critical habitat will be exposed to these physical disturbance impacts throughout the year. Some plants may be less able to sustain or recover from these disturbances if already under physiological stress from excessively dry or wet conditions. The number of individuals that will be exposed is discussed in the species-specific effects analyses that follow. Disturbance effects in critical habitat also will adversely affect native plants and substrates that comprise the primary constituent elements determined to be essential for the survival and recovery of listed plants and the Oahu elepaio.

Response of Listed Resources to Physical Disturbance

Over time, military use of the Kuaokala Trail, particularly in narrow portions, will reduce vegetation cover adjacent to the trails and result in less suitable habitat for listed plants, tree snails, and the Oahu elepaio. Listed plants and tree snails adjacent to the trail are at risk of injury and death as a result of trampling and breakage by personnel during troop marches and in conjunction with various fire and conservation management activities. Further impacts to listed resources, and indirect impacts resulting in habitat degradation, will occur if personnel stray off the trails. The response of listed resources that will be directly exposed to trampling and breakage includes both lethal (death) and sub-lethal components (injury to leaves, stems, roots, growing tissues, buds, flowers, fruits, and seeds; and to tree snails dislodged from their host trees).

Physiological stress in plants due to loss of leaf area results in decreased photosynthesis and increased transpiration water stress. Repeated foot traffic disrupts the soil surface or compacts near-surface horizons, resulting in soil loss or compaction. The root systems of plants adjacent to trails are either exposed by displaced soils or smothered by compacted soils; either condition can result in restricted water/nutrient uptake in the plant. Loss of flowers, fruits, or meristematic tissue on branches and stems temporarily halts plant reproduction or growth. The physiological stress resulting from these injuries will reduce overall vigor, growth, and fecundity of individual plants. The consequences of physiological stress on individual plant fitness will vary among individuals, ranging from reduced growth and vigor, to reduced reproduction and recruitment, to delayed mortality. The overall effect of exposure to human disturbance will be reduced individual fitness and a contribution to further decline in numbers and population viability.

General Effects of Small Population Size

Many of the listed plant taxa within the action area are limited in abundance and distribution, with low numbers of individuals and populations. Five of the 28 target plant taxa to be stabilized under the Makua Implementation Plan Addendum currently consist of fewer than 100 individuals range-wide (*Chamaesyce herbstii*, *Gouania vitifolia*, *Hesperomannia arbuscula*, *Phyllostegia kaalaensis*, and *Schiedea nuttallii*). Small populations are more vulnerable than large populations to extirpation from naturally occurring events (environmental stochasticity), reduced reproductive vigor (demographic stochasticity), or a combination of both factors (Dennis et al 1991; Schemske et al 1994). Demographic stochasticity refers to random effects on population vital rates (birth, growth, survival) resulting from chance variation among individuals in survival or reproduction (due, for example, to lack of pollination or seed dispersal). Environmental stochasticity refers to random effects on population vital rates resulting from chance variation in the occurrence of natural events or disturbances related to weather, competition, predation, or disease. The limited gene pools of small plant populations also may depress reproductive vigor through loss of genetic variation resulting from inbreeding, accumulation of deleterious mutations, and genetic drift. Reduced genetic variability in a population thus represents a decline in individual fitness, population viability, and resilience to environmental change.

Although many population viability analysis (PVA) models show that small populations are at greater risk of extirpation due to stochastic processes than large populations, little empirical evidence exists for plants. In one study, for example, the relationship between population size and survival over 10 years was tracked for 359 occurrences of eight short-lived (annual and biennial), threatened plants in northern Germany (Matthies et al 2004). Based solely on changes in numbers, large populations had a significantly greater probability of survival over the 10-year study period than small populations. Most occurrences consisting of fewer than six and many with fewer than 100 individuals did not survive over 10 years, while occurrences of more than 1,000 individuals survived. Although the study did not track disturbance factors, the local extirpations of some populations likely were caused in part by stochastic processes, because many other small populations did survive and grow larger. For the eight species, estimated population size required for 90 percent probability of survival over 10 years varied widely, from 71 to 1,276 individuals (Matthies et al 2004).

In another study, a PVA model estimated rates of environmental stochasticity (natural catastrophe) and predicted the extinction probability of an endangered riparian plant in the northeastern United States (Menges 1990). The model was based on demographic data from over 6,000 individual plants in 17 populations monitored over four years. The observed zero to six percent annual probability of natural catastrophe (riverine ice scour) predicted only a 13 percent probability of species survival over 100 years. The author concluded that protecting the "best" populations may not necessarily ensure a species' persistence; dispersal and establishment of new colonies may be essential to avoid species extinction due to natural disturbance regimes. Even so, few species in the Makua action area consist of thousands of individuals in many occurrences. We infer from this and the previous example that many Makua species also will have a low probability of persistence in the face of periodic, catastrophic disturbance.

According to current conservation biology principles, demographic and environmental variation, including catastrophic occurrences (such as flooding or fire), are important determinants of population extinction for plants (Menges 1990; Mangel and Tier 1994; Schemske et al 1994). A general pattern of population collapse has been documented for a wide range of plant and animal species with small population sizes (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000). According to this pattern some species in the action area already are in a phase of "quasi-extinction," with numbers that have declined to the point where environmental or demographic stochasticity alone can result in extirpation. (Quasi-extinction refers to a specified population threshold considered too low for species survival.) Such species have a high background risk of extinction and any additional threats, such as training-related wildfire, could eliminate expectation of their long-term persistence.

Dennis et al (1991) developed statistical methods for estimating growth rates and quasi-extinction probabilities for populations of several endangered bird and animal species, based on 15 to 40 years of time-series monitoring data. Results predicted that, without intensive management, the Yellowstone grizzly bear population, Kirtland's warbler, California condor, and Puerto Rican parrot would decrease to 10 or fewer reproducing adults in 13 to 109 years. Graphical representations of population trends for these species indicate the general pattern of population collapse except for the parrot. Numbers of Puerto Rican parrots are increasing, but solely due to release of captive-reared birds, protection of juveniles, and intensive habitat management; the breeding population has remained nearly constant, and effects of environmental catastrophes like hurricanes were not considered in the model. For plants, Burgman et al (2001) defined quasi-extinction risk as a 0.1 percent probability of decline below 50 adult individuals over 50 years, and used this criterion to determine a species' background probability of persistence. Although lack of demographic data precludes PVA modeling or quantification of quasi-extinction risks for Hawaiian native plants, the 50-adult threshold generally used in conservation practice indicates the extirpation danger faced by species with small population sizes in the Makua action area.

The factors that caused a species' extinction are generally unknown (Gurevitch and Padilla 2004). Norton (1991) was able to document these factors for *Trilepidea adamsii*, an endemic New Zealand mistletoe species. *Trilepidea adamsii* is now presumed extinct due to interacting factors of habitat loss, limited distribution, reduced seed dispersal, overcollecting, and browsing by the non-native brushtailed possum (*Trichosurus vulpecula*). In the United States, the heath hen (*Tympanuchus cupido cupido*) was driven to extinction by a combination of catastrophes including fire, harsh winter weather, predation, and disease (cited in Mangel and Tier 1994). Catastrophes combined with other kinds of environmental fluctuation have been associated with extinction of the great auk (*Pinguinus impennis*) and with the severe population decrease of the Laysan duck (*Anas laysanensis*) and short-tailed albatross (*Phoebastria albatrus*) (cited in Mangel and Tier 1994).

Burgman et al (2001) list plant ecological and life history factors that are likely to contribute to extinction vulnerability in plants, based on the population size required to provide an adequate probability of persistence. Those factors we consider descriptive of action area plants include: few small, isolated populations; restricted distribution; adaptation to unique habitat requirements; wide fluctuations in population size; low post-disturbance regeneration rates; slow, weak growth, poor competitive ability; susceptibility to fire injury/death; lack of adaptation to browsers; drought, or fire regimes; inability to resprout; and vulnerability to non-native pathogens, disease, and insects. Our understanding of the factors that contribute to the extinction vulnerability of action-area species are poorly understood, but may include: dysfunctional breeding systems (i.e., loss of pollinators), variable seed production, low seed production and viability, and no longer functioning seed dispersal mechanisms (i.e., loss of seed dispersal).

Factors that contribute to demographic and environmental stochasticity in the action area include naturally occurring events such as drought and landslides, catastrophic events such as hurricanes and wildfire, competition from non-native invasive plants, predation and herbivory by non-native animals and invertebrates, and trampling and uprooting by feral ungulates. The Service infers from the theories and examples of the current conservation biology literature discussed in this section that some species within the action area are vulnerable to extinction due to random demographic, environmental, and catastrophic events (including training-related wildfire). We also infer from the results of statistical models and population viability analyses provided by these examples, that if adequate data were to become available for the action-area species whose population sizes are small, statistical models would likely demonstrate a the probability of long-term persistence is low.

General Effects - Fire Suppression

Fire History

All fires caused by live-fire training, for which records are available, were successfully suppressed during the initial attack period. Fire perimeter maps were generated for the 35 training-related fires that burned outside the firebreak road between 1970 and 2006 (Figure E 1). Most fire perimeters were digitized based on maps in Army fire reports. Fires for which perimeter maps were not found were mapped as ovals centered at the fire's reported grid location, equal in acreage to the fire's reported size.

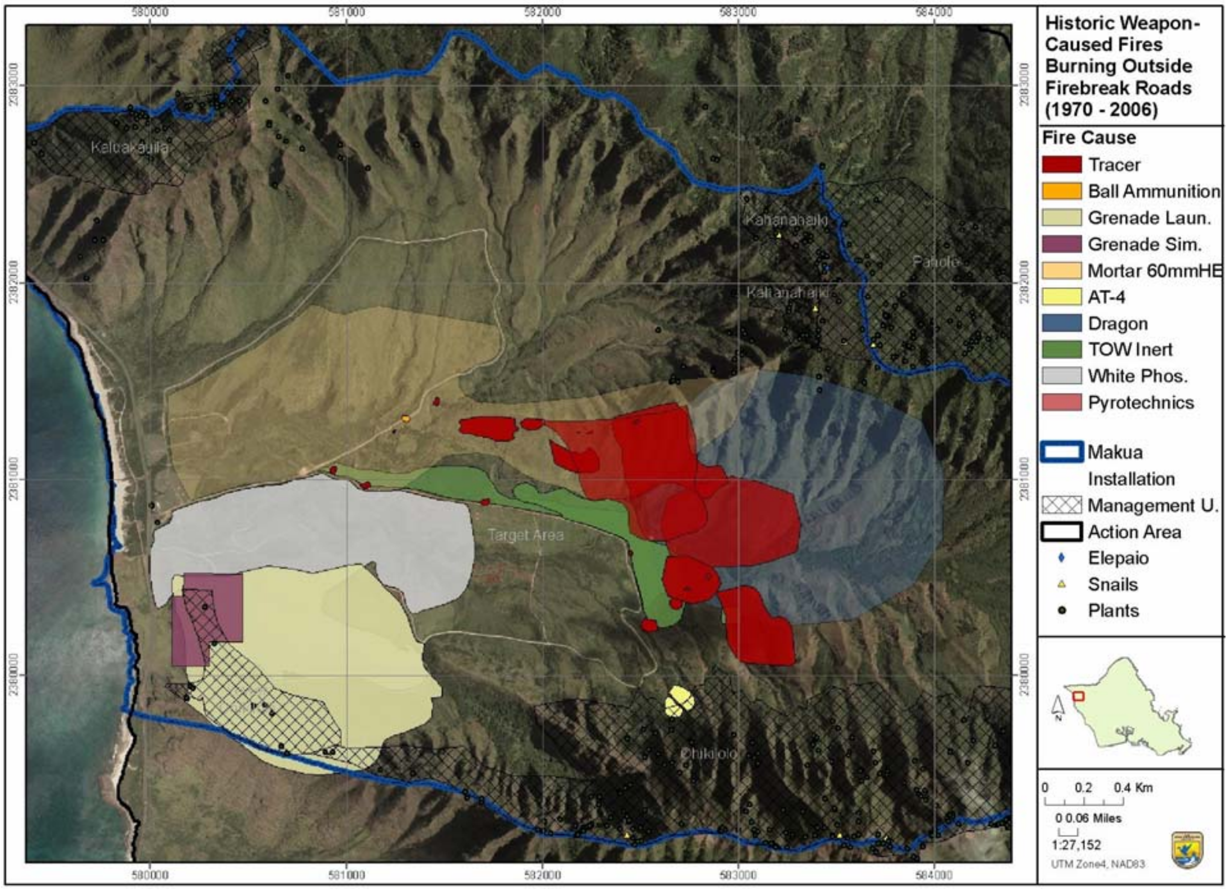


Figure E 1. Weapon-related fires burning outside the firebreak road at Makua (1970-2006).

All documented wildland fires that have occurred at Makua as a result of the proposed weapons are summarized in Table E 2, listed in order of total number of fires ignited. Fires ignited by the public along Farrington Highway are not analyzed. Although white phosphorus rounds are no longer used at Makua, remnant white phosphorus rounds may ignite fires, which could impact endangered species and critical habitat areas.

Table E 2. Fire Ignitions by Weapon, Location, and Fire Danger Rating Period.

Weapon Causing Fire	Total # Fires (recorded 1970 - 2005*)	Percent of Fires Ignited by Weapon	Number of Fires Burning Outside Firebreak Road	Percent of Fires that Burned Outside Firebreak Road	Percent of all Fires Outside Firebreak Road Caused by Weapon	Fire Danger Percent of Historic Fire Starts (1970 - 2005)		
						Green	Yellow	Red
Tracers	156	61%	23	15%	68%	3%	84%	14%
Javelin/Dragon	33	13%	1	3%	3%	0%	31%	69%
Demolitions	17	7%	0	0%	0%	11%	0%	89%
Ball Ammo	15	6%	1	7%	3%	0%	63%	38%
Mortars/Artillery	10	4%	1	10%	3%	0%	13%	88%
2.75 Rocket	7	3%	unknown	unknown	unknown	unknown	unknown	unknown
Mines / Simulators	6	2%	1	17%	3%	0%	0%	100%
TOW	5	2%	4	80%	12%	0%	0%	100%
AT-4/SMAW	4	2%	2	50%	6%	0%	100%	0%
Grenades	3	1%	1 (MK19)	33%	3%	0%	0%	100%
TOTALS:	256	100%	34		100%			

* Beavers et al (1999) and U.S. Army Fire Reports (unpublished)

<u>Tracers</u> Of the 156 recorded tracer fires, 23 occurred outside the firebreak road, accounting for 68 percent of all fire ignitions outside the firebreak road. Although 85 percent of tracer fires burn entirely within the firebreak road, tracers which overshoot the target may not burn out until after they cross the firebreak road, and burning material from tracers can ricochet and ignite a fire outside the firebreak road. Of the 93 tracer fires for which fire danger rating index was recorded, only three ignited when the fire danger rating was Green. Two of those three ignitions occurred outside the firebreak road. On March 30, 1994, a tracer fire burned 0.5 ha (1.1 ac) outside the firebreak road and was extinguished in 1.3 hours after 11 bucket drops from a Blackhawk helicopter (Army Fire Report 1994). On March 16, 1995, a tracer fire burned 0.004 ha (0.0091 ac) outside the firebreak road and was extinguished in 35 minutes with two bucket drops from a Blackhawk helicopter. Eighty-four percent of all of the tracer fires recorded ignited when fire danger rating conditions were in the Yellow, and 14 percent of all tracer fires occurred when fire danger rating conditions were in the Red. Tracer fires burning outside the firebreak road under Yellow and Red fire danger conditions ranged in size from 0.004 ha to 88 ha (0.01 to 217.5 ac) (average 8 ha (19.8 ac)); it took between zero and five helicopters to suppress them, and suppression times ranged from 9 minutes to 12 hours and 20 minutes (Army Fire Reports 1990 through 1995 and Beavers et al 1999).

Restriction of the use of tracers to seasons when live herbaceous fuel moisture is 100 percent or higher and to periods when the burning index is 20 or lower (Fire Danger Rating Green) will minimize the fire risk associated with the use of this weapon. Even with these restrictions in place, tracers are likely to ignite fires outside the firebreak road. Therefore, no tracers will be used until Kaluakauila, Kahanahaiki and Ohikilolo management unit perimeter fire protection systems are completed. Furthermore, tracer use will be limited to live herbaceous fuel moistures of 100 percent or greater until the expedited stabilization of 12 species is completed. The static firing point and 1,800 m (5,906 ft) burnout distance of the M1 is expected to limit all ignitions to the area where historic fire ignitions from this weapon appear to have been ignited (Figure E 2).

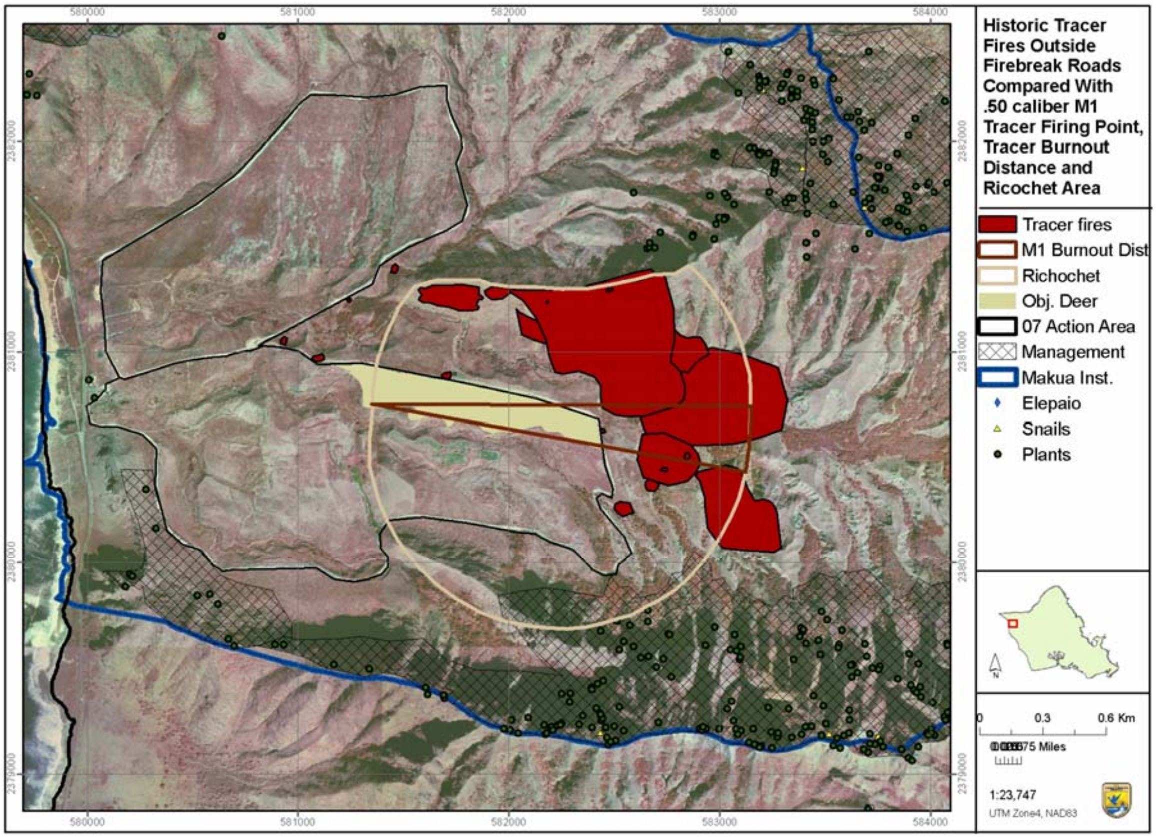


Figure E 2. Historic tracer fires outside firebreak roads compared with .50-caliber M1 tracer burnout distance and potential tracer ricochet area.

Current understanding of the guinea grass fire behavior in green grass and fire suppression capabilities of assigned aerial firefighting resources indicates that fires ignited outside the firebreak road when live herbaceous fuel moisture is 100 percent or greater and fire danger rating is Green/Low are likely to be contained at sizes smaller than approximately 8 ha (20 ac). Estimated size of a fire still burning at 1 p.m. on a 97th percentile fire weather day is 58.3 ha (144 ac) (Table PD 11). It is possible that a spot fire, spawned by a fire burning in Makua Valley, could ignite within the forest vegetation of a management unit. Our best understanding of fire behavior and helicopter fire suppression capabilities in forest fuels indicates that the assigned Makua suppression helicopter staffing, designed to suppress fires in heavy guinea grass fuels, will be sufficient to suppress a fire ignited by this weapon in shrub or forest fuels at 0.12 ha (0.3 ac) or less, even if the fire ignites on a 60 percent slope, with upslope winds of 18 mph and 1-hour fuel moisture of six percent. If a spot fire ignited in local forest fuels were to burn undetected for 48 hours, it could grow to more than 40.5 ha (100 ac). These results are dependent on helicopter productivity in forest fuels being equal to helicopter productivity in guinea grass fuels. Our analysis of fire behavior in guinea grass indicates that spot fires are not likely to occur when live herbaceous fuel moisture is 100 percent or greater. A detailed analysis of spot fire potential is addressed in the prescribed burning and firebreak portions of this section of the Biological Opinion, below. Fire suppression helicopter productivity in forest fuels will be accumulated by firefighters suppressing fires throughout the Waianae Mountains over the next 15 years. Because tracer use will be restricted to seasons when live herbaceous fuel moisture is 100 percent and greater for approximately 15 years while the expedited stabilization of 12 endangered plants is being completed, fires ignited by tracers are unlikely to cause spot fires in forest fuels until after more thorough assessments of anticipated acreages of these fires are completed.

Javelin The second most frequent cause of fire at Makua was the Dragon missile, the precursor to the Javelin. Thirty-three fire ignitions, including one outside the firebreak road (a 162-ha; 400-ac) fire in 1989), are documented to have been ignited by use of Dragon missiles (Beavers et al 1999). The new Javelin is a self-guided warhead, and locks onto and fires at a heat source. At 1,000 m (0.6 mi), the flight motor is fully exhausted. Therefore, the surface danger zones and potential ignition areas (see Figure PD 29) created for flat terrain overestimate the maximum range of the weapon. On impact, the detonation is likely to create enough heat to ignite a wildland fire. Although the Javelin is a guided weapon, it has the potential to malfunction and ignite fires within management units populated by endangered species. Therefore this weapon will not be used until the expedited stabilization of 12 endangered plant species is completed. The restriction of the use of this weapon to Green fire danger rating periods and periods of time when live herbaceous fuel moisture is 100 percent or higher will further reduce the fire risk associated with the use of this weapon.

Current understanding of the guinea grass fire behavior in green grass and fire suppression capabilities of assigned aerial firefighting resources indicates that fires ignited outside the firebreak road when live herbaceous fuel moisture is 100 percent or greater are likely to be contained at sizes smaller than approximately 8 ha (20 ac). Estimated size of a fire still burning at 1 p.m. on a 97th percentile fire weather day is 58.3 ha (144 ac) (see Table PD 11). Therefore, no Javelin will be fired until Kaluakauila, Kahanahaiki and Ohikilolo management unit perimeter fire protection systems are completed and the expedited stabilization of 12 species is achieved. Our best understanding of fire behavior and helicopter fire suppression capability in forest fuels indicates that the assigned Makua suppression helicopter staffing, designed to suppress fires in heavy guinea grass fuels, will be sufficient to suppress a fire ignited by this weapon in shrub or forest fuels at 0.12 ha (0.3 ac) or less, even if the fire ignites on a 60 percent slope, with upslope winds of 18 mph and 1-hour fuel moisture of six percent. If a Javelin fire ignited in local forest fuels were to burn undetected for 48 hours, it could grow to more than 40.5 ha (100 ac). One-hour fire detection flights will be flown by the Army Wildland Fire Incident Commander and, if there are multiple on-site helicopters, by additional firefighters, following the use of a Javelin.

Demolitions None of the 17 fires caused by demolitions at Makua burned outside the firebreak road (Beavers et al 1999). Most demolition-caused fires were extinguished at less than one acre (Beavers et al 1999). On July 25, 1991, Range Control personnel contained a demolitions caused fire to 162 ha (400 ac), within the south lobe of the firebreak road. Unexploded ordinance disposal demolitions may occur outside the firebreak road when live herbaceous fuel moisture is 100 percent or higher and fire danger rating is in the Green. Fire suppression helicopter staffing will be on-site to suppress any fire ignition in an inaccessible area.

Ball Ammunition Only one of the 15 recorded ball ammunition fires occurred outside the firebreak road. It ignited under Yellow fire danger conditions on April 30, 1991, burned the inside and outside grass edges of the north lobe of the firebreak road, and was extinguished at 0.01 ha (0.037 ac) by ground forces in 13 minutes (Army Fire Report 1991). It is not clear from the fire report whether this road location was being used as a firing point. An August 29, 1990, ball ammunition fire with a recorded location inside the south lobe of the firebreak road had an approximate area of 324 ha (800 ac). Given that the total acreage within the south lobe of the firebreak road is approximately 136 ha (337 ac) and the north lobe contains an additional 186 ha (459 ac), it is assumed that the acreage reported in the fire report was inaccurate and that this fire did not burn outside the firebreak road. The fire report stated that notifying the Service was not required, which would have been the case if the fire was outside the firebreak road. Muzzle flash and hot particles resulting from the use of short-range training ammunition and blanks may ignite fires in the vicinity of the firing point. Because spot fires may result from fires burning in unmowed guinea grass stands within the south lobe of the firebreak road, short-range training ammunition and blanks may be used with reduced fire suppression helicopter staffing (see Table PD 4) when the use is limited to designated areas where there is a bare mineral soil firebreak between the firing point and any unmowed guinea grass fuels in the interior area of the south lobe of the firebreak road.

Mortars and Artillery Seven mortar fires are recorded, including one that ignited outside the firebreak road (Beavers et al 1999). One 60 mm mortar fire ignited a fire outside the south lobe of the firebreak road on September 16, 1998, due to an apparent misalignment of the firing trajectory. Five helicopters working during the day and two helicopters working at night made a total of 432 bucket drops to extinguish the fire. The fire report indicates a fire size of 324 ha (800 ac). GIS analysis of the digitized fire perimeter indicates that the fire acreage may be updated to a size of 176 ha (434 ac). Between October 2001 and June 2004, between 469 (U.S. Army, unpublished fax, January 10, 2006) and 1,992 (U.S. Army unpublished information paper May 14, 2007) inert and HE mortars were fired in Makua. Although rigorous measures had been instituted to minimize the risk of rounds landing outside the firebreak road, in several instances mortar impacts outside the firebreak road (adjacent to the target area, in Makua Stream, and on C-Ridge) were documented by civilian observers (*Malama Makua v. Donald H. Rumsfeld*, 2006). Therefore, mortar ignitions of fires outside the firebreak road appear to be inevitable.

Three artillery fires (September 4, 1991; May 25, 1993; and April 7, 1994) are recorded (Beavers et al 1999). None escaped the interior of the south lobe of the firebreak road. They ranged in size from 0.4 ha (0.9 ac) to 30 ha (75 ac), and it took zero, one, and two helicopters and ground firefighting resources to suppress them. Fire danger indices are recorded for two of them and these both occurred in Red fire danger conditions. Although the Project Description stipulates all munitions will land within the impact area, ignitions outside the firebreak road are anticipated because the potential ignition area designated for artillery (see Figures PD 21, PD 23) extends outside the firebreak road.

Current understanding of the guinea grass fire behavior and fire suppression capabilities of assigned aerial firefighting resources indicates that a fire ignited outside the firebreak road under 97th percentile fire weather conditions, when live herbaceous fuel moisture is 60 percent, is likely to burn 271 ha (669 ac) (Table PD 11). Therefore, use of mortars and artillery will be restricted to Green fire danger conditions when live herbaceous fuel moisture is lower than 100 percent, until Kaluakauila, Kahanahaiki and Ohikilolo management unit perimeter fire protection systems are completed and the expedited stabilization of three species is achieved (see Column C, Table PD 2). Prior to fuelbreak completion, mortars may ignite fires outside the firebreak road when live herbaceous fuel moisture is 100 percent or greater, but fire acreages are expected to be 58 ha (144 ac) or less. These smaller fires are less likely to reach endangered species locations.

2.75-caliber rocket In 1987 and 1988, seven fires ignited by 2.75-caliber rockets are recorded to have occurred in May (two fires), June (one fire), August (three fires) and October (1 fire). One fire took approximately two hours to extinguish and another was declared out after approximately six hours (Beavers et al 1999). Fire danger, location, and size information are not available.

We assessed the effect of 2.75-caliber rocket fire ignitions within the surface danger zones presented by the Army (Figure PD 27). The inaccuracy of this weapon is likely to result in rocket impacts outside the south lobe of the firebreak road. A passing score for a 2.75-caliber rocket qualification exercise is one out of three, or three out of seven hits within a 100 by 100 m (328 by 328 ft) box around a tank-sized object (S. Lodge, U.S. Army, pers. comm. 2006). Approximately one third of the target box's perimeter is bounded by the firebreak road. Out of the approximately 5,040 rounds scheduled for use over the next 30 years (Table PD 3), a maximum of 3,360 rounds may land outside the target box, and approximately one third of those, or 1,120 rockets, may land outside the firebreak road. Limitations in the use of this weapon to fully qualified pilots, who are not firing the weapon for training or recertification purposes, assure that this estimate would not be exceeded.

Although the Army is minimizing the risk of fire by firing only MK66 MOD 4 rocket motors, and blue spear WTU1B inert, ten-pound steel training warheads, with motor propellant that burns out at approximately 450 m (1,476 ft), the tube remains hot enough that it can ignite vegetation on impact 3.0 km (1.9 mi) down-range (S. Lodge, U.S. Army Garrison, pers. comm. 2006). Although the likelihood of a fire ignition from a 2.75-caliber rocket is not as great as fire ignition likelihood from a tracer (S. Lodge, U.S. Army pers. comm. 2006), fire ignitions outside the firebreak roads resulting from this weapon are expected. Therefore, use of this weapon will be restricted to seasons when the live herbaceous fuel moisture, calculated by the Makua Range weather station, is 100 percent or greater, and furthermore, to periods when the burning index is 20 or lower and the fire danger is rated Green/Low as a result of high fuel moistures and/or light winds.

Current understanding of the guinea grass fire behavior in green grass and fire suppression capabilities of assigned aerial firefighting resources indicates that fires ignited outside the firebreak road when live herbaceous fuel moisture is 100 percent or greater are likely to be contained at sizes smaller than approximately 8 ha (20 ac). Estimated size of a fire still burning at 1 p.m. on a 97th percentile fire weather day is 58.3 ha (144 ac) (see Table PD 11). Therefore, no 2.75-caliber rockets will be fired until Kaluakauila, Kahanahaiki and Ohikilolo management unit perimeter fire protection systems are completed and expedited stabilization of 12 species is achieved. Our best understanding of fire behavior and helicopter fire suppression capability in forest fuels indicates that the assigned Makua suppression helicopter staffing, designed to suppress fires in heavy guinea grass fuels, will be sufficient to suppress a fire ignited by this weapon in shrub or forest fuels at 0.12 ha (0.3 ac) or less, even if the fire ignites on a 60 percent slope, with upslope winds of 18 mph and 1-hour fuel moisture of six percent. If a 2.75-caliber rocket fire, ignited in local forest fuels were to burn undetected for 48 hours, it could grow to more than 40.5 ha (100 ac). One hour fire detection flights will be flown by the Army Wildland Fire Incident Commander, and, if there are multiple on-site helicopters, by additional firefighters, following the use of 2.75-caliber rockets. This fire detection plan appears to be sufficient to ensure that all fires ignited in forest areas that are not visible from the Range Control tower are immediately detected and suppressed.

<u>Mines and Simulators</u> On March 18, 1998, a grenade simulator ignited a fire outside the firebreak road in the vicinity of Lower Ohikilolo, burning 20.2 ha (50 ac) inside and outside the firebreak road. Three helicopters (a Ch-47, a Ch-53 and a UH-60) dropped 50 bucket drops on the fire during the 3 hour and 50 minute suppression period.

<u>TOW</u> Malfunction rate information for the TOW is limited. Data published by Redstone Arsenal for airborne TOW missiles fired in combat in 1972 and 1973 indicates that 82 percent of TOW missiles hit their targets, seven percent malfunction (http://www.redstone.army.mil/history/tow/tow_chronology.htm.). TOW use will be limited to periods when live herbaceous fuel moisture is 100 percent or greater, limiting the use of the TOW to the three to seven month wet part of the year. Although the TOW missile is inert, the rocket motor may still be hot enough to ignite a fire when it lands. Current understanding of the guinea grass fire behavior in green grass and fire suppression capabilities of assigned aerial firefighting resources indicates that fires ignited outside the firebreak road when live herbaceous fuel moisture is 100 percent or greater are likely to be contained at sizes smaller than 8 ha (20 ac). Estimated size of a fire still burning at 1 p.m. on a 97th percentile fire weather day is 58.3 ha (144 ac) (Table PD 11). Therefore, no TOW missiles will be fired until Kaluakauila, Kahanahaiki and Ohikilolo management unit perimeter fire protection systems are completed and full stabilization of 12 species is achieved. Our best understanding of fire behavior and helicopter fire suppression capability in forest fuels indicates that the assigned Makua suppression helicopter staffing, designed to suppress fires in heavy guinea grass fuels, will be sufficient to suppress a fire ignited by this weapon in shrub or forest fuels at 0.12 ha (0.3 ac) or less, even if the fire ignites on a 60 percent slope, with upslope winds of 18 mph and 1-hour fuel moisture of six percent. If a TOW fire, ignited in local forest fuels were to burn undetected for 48 hours, it could grow to more than 40.5 ha (100 ac). One hour fire detection flights will be flown by the Army Wildland Fire Incident Commander and, if there are multiple on-site helicopters, by additional firefighters, following the use of TOW missiles. This fire detection plan appears to be sufficient to ensure that all fires ignited in forest areas which are not visible from the Range Control tower, are immediately detected and suppressed. If a TOW fire occurs in the shrub/forest vegetation, the proposed fire detection and fire suppression staffing protocols will minimize the risk of damage by fire.

<u>AT-4 / SMAW</u> Two of the four recorded fires resulting from AT-4 use at Makua were located outside the firebreak road (Beavers et al 1999) (see Figure E 1). All four fires

occurred in July or August when live herbaceous fuel moisture was likely to have been low. Fire sizes ranged from 0.004 ha (.01 ac) to 1.2 ha (3 ac) and were suppressed with between zero and two Blackhawk helicopters. Between 2001 and 2004, a total of 18 AT-4 rounds were fired in Makua (U.S. Army, unpublished fax, July 2004) and only one 2 by 2 m (6.6 by 6.6 ft) fire occurred (G. Enriques, U.S. Army Garrison, pers. comm. 2006). By restricting use of the AT-4 to periods of low fire danger when live herbaceous fuel moisture is less than 100 percent, the Army is minimizing the risk that use of this weapon will result in a large fire outside the firebreak road.

Grenades An MK-19 round ignited a fire outside the firebreak road on June 26, 1993, when fire danger was in the Red. Three helicopters suppressed the fire at approximately 2 ha (5 ac). There are no records of an M79 or M203 causing fires (Beavers et al 1999). To minimize the risk of a large fire outside the firebreak road, only inert MK19 practice rounds will be fired at Makua when live herbaceous fuel moisture is lower than 100 percent. Live MK19 rounds may be used during periods when live herbaceous fuel moisture is 100 percent or higher, and after management unit fuelbreaks and expedited stabilization of three endangered plant species is completed. Fire acreages are expected to be relatively small under these higher live herbaceous fuel moisture conditions (see Table PD 11).

Historic Fires Escaping Initial Attack

Four large fires not directly associated with live-fire training, but according to fire reports ignited within the military reservation, have burned the Makua Valley (Figure E 3).

On August 5, 1970, a cigarette caused a fire that burned 617 ha (1,525 ac) within and to the north of Makua Valley (Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife Fire Records 1970). According to Pat Costales (Hawaii Department of Land and Natural Resources, pers. comm. 2006), suppression forces battling the 1970 Makua fire were limited to ground forces. This fire was suppressed when it reached accessible areas.

According to State of Hawaii fire records (Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife Fire Records 1984), at 3:00 p.m. on May 16, 1984, a fire was observed burning in the vicinity of the observation tower near Farrington Highway at Makua. The fire record indicates that no action was taken to suppress this fire until 8:20 the following morning. The fire burned into the intact shrub vegetation (Costales, Hawaii Department of Land and Natural Resources, pers. comm. 2007). GIS interpretation of the fire perimeter indicates that the final fire size was 704 ha (1,740 ac). According to weather records maintained by Glenn Shishido (Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, Forest Management Supervisor, Maui District) and Pat Costales, May 1984 was likely a drought period at Makua. A strong El Niño event in 1983, followed by a developing La Niña event, appeared to have resulted in a lack of winter rains in early 1983 over much of the State (P. Costales and G. Shishido, Hawaii Department of Land and Natural Resources, pers. comm. 2006). Live herbaceous fuel moisture data for the Kahului Airport area on Maui, which receives similar annual average rainfall totals to Makua Valley, suggests that live herbaceous fuel moisture was below 60 percent in May 1984 (G. Shishido, pers. comm. 2007). To ensure that fires do not burn under the worst

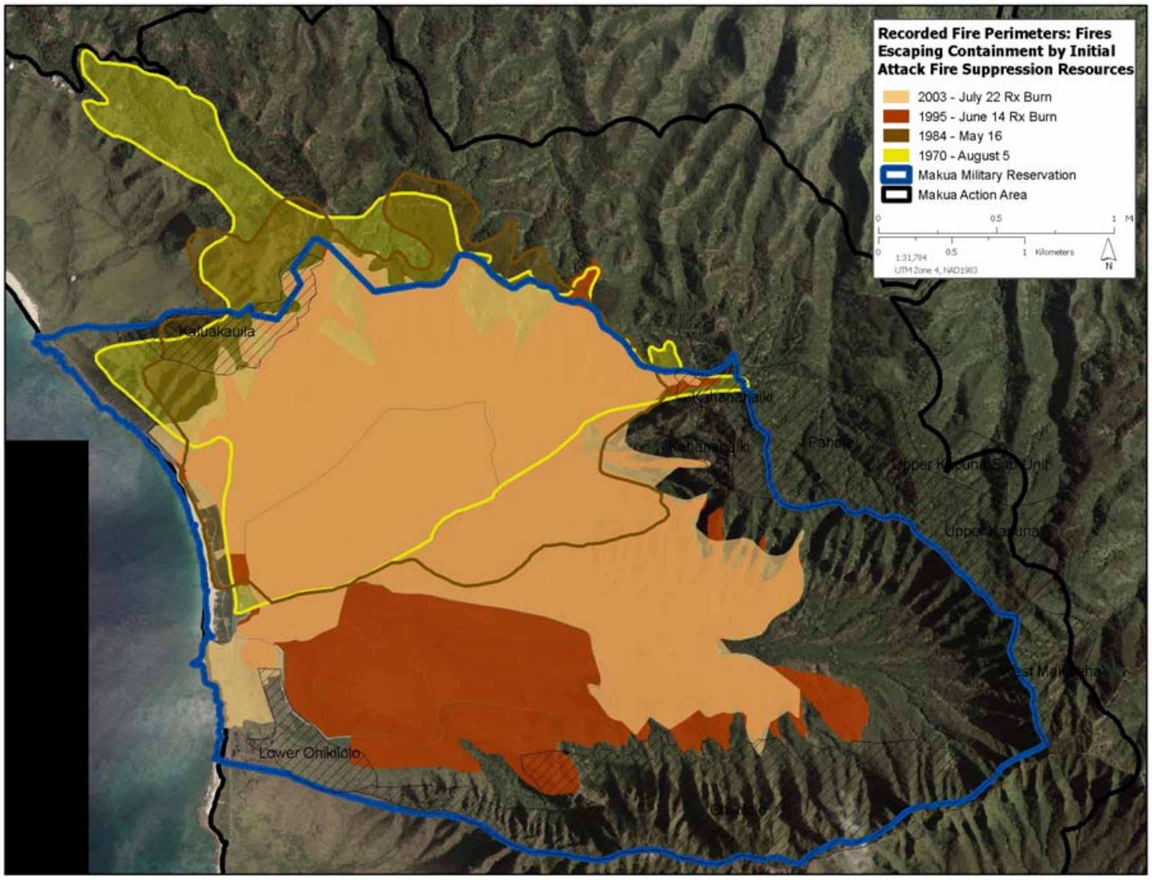


Figure E 3. Recorded perimeters of four fires that escaped initial attack fire suppression resources at Makua.

drought conditions when shrubs would be more susceptible to burning, all live-fire training will be restricted to periods when live herbaceous fuel moisture is 60 percent or higher.

We have records for four prescribed burns conducted by the Army at Makua that escaped containment. Records indicate that three of them were conducted in a manner inconsistent with the prescribed burn plans that were agreed to by the Service during the Section 7 consultation process. A short description of each burn is outlined below.

Beavers et al (1999) cite the cause of the August 11, 1987, fire at Makua as a prescribed burn escape. No additional information about this fire is recorded.

On April 18, 1990, the Service received a letter from the Army requesting initiation of formal consultation for the implementation of a controlled burn in Makua Valley. A burn (or burns) was conducted in early July 1992, outside the fuelbreak roadway system to expose the ground to facilitate the work of Army engineers and planners who were extending the outer firebreak road system. The fire(s) escaped control and burned up several lower-elevation side ridges. According to our August 21, 1992 letter to the Army, the proposed burns were supposed to be conducted within areas encircled by a network of firebreaks. No fire report or map is available for this fire.

On May 16, 1995, the Service received Prescribed Fire Plan 95-1 for Makua outlining procedures that would be followed for burning an area outside the firebreak road, utilizing chemical retardant as a fireline. Two helicopters were required to be on-site during the prescribed burn of Area C, with one helicopter on standby at Wheeler Army Airfield (Army 1995). On June 2, 1995, the Service concurred with the Army's determination that the prescribed burn was not likely to adversely affect listed species. On June 14, 1995, after areas inside the firebreak road had been successfully burned utilizing Prescribed Fire Plan 95-1, Area C, on C-Ridge, outside the firebreak road, was burned. The retardant was not substantial enough and the fire crept through the line in several places (D. Bowen, Service, pers.comm. 1995). The upper dip site had not been completed when this fire escaped. Service employees who witnessed the prescribed burn believe that with trained pilots and on-site fire suppression helicopter fueling at Makua, this prescribed burn may not have escaped (D. Bowen, Service, pers.comm. 1995). They also recommended that future burns be conducted during the rainy season instead of the driest time of the year (D. Bowen, pers. comm. 1995). The inexperience and insufficient number of fire suppression helicopters contributed to this fire escape. GIS analysis of the digitized fireline presented in the U.S. Army fire report indicates that the fire burned approximately 998 ha (2,465 ac) (Figures E 3 and E 4). On August 9, 1995, the Service provided the Army with a letter documenting impacts of the escaped prescribed burn to endangered *Lipochaeta tenuifolia* (now *Melanthera tenuifolia*) (fewer than 20 plants burned), *Lobelia niihauensis* (one or two may have burned), *Neraudia angulata* var. *angulata* (one plant burned), *Nototrichium humile* (approximately 90 plants burned), and *Tetramolopium filiforme* (approximately 20 plants burned) individuals. No prescribed burns outside the firebreak road are proposed in the current Project Description.

Figure E 4. Service photographs taken after the 1995 escaped prescribed burn (Service, 2005).

On November 25, 2002, the Service received a letter from the Army requesting initiation of formal consultation for the implementation of a prescribed burn at Makua described in The Environmental Assessment for a Prescribed Burn at Makua Island of Oahu, August 2002 (U.S. Army Garrison 2002). The Service reviewed the prescription parameters and determined that the burn was not likely to adversely affect listed species. On July 22, 2003, a prescribed burn being conducted inside the north lobe of the firebreak road at Makua escaped to burn a total of 850 ha (2,100 ac) (U.S. Army Garrison, Army Natural Resources, August 2003). Approximately 60.7 ha (150 ac) of unoccupied Oahu elepaio critical habitat on Army lands at Makua and approximately 2.4 ha (6 ac) of plant critical habitat on State land were burned in this fire (Figures E 3 and E 5).

Figure E 5. Areas burned by the 2003 escaped prescribed burn (Army Natural Resources, August 8, 2003).

The July 22, 2003 prescribed burn was conducted on a day when weather conditions were predicted to be outside the limits specified in the 2002 Prescribed Burn Environmental Assessment (U.S. Army Garrison 2002) for temperature, relative humidity, 1-hour fuel moisture, and wind speed (Table E 3). The prescribed burn escaped containment by initial attack resources and burned at least 37 *Chamaesyce celastroides* var. *kaenana*, 29 *Melanthera tenuifolia* (*Lipochaeta tenuifolia)*, and five *Nototrichium humile* individuals (U.S. Army Garrison, 2003).

Table E 3. Conditions on July 22, 2003, were not forecasted to be in prescription for burning based on the prescription in the 2002 Prescribed Burn Environmental Assessment (U.S. Army Garrison 2002).

Weather and Fuel Moisture Parameters: Prescribed, Forecasted, and Observed: Makua Prescribed Burn July 22, 2003.	**Prescription USFWS Consultated on and Agreed to (2002 EA)**	**Spot Weather Forecast ***	**Actual Observed Weather at Makua Range Wx Station ****
Temperature (Degrees F)	**65-85**	**HI NEAR 90**	**82-87**
Relative Humidity (%)	**50-80**	**MIN 45-50**	**43-52**
1-hour fuel moisture (%)	**10-20**	**7**	**6**
Eye-Level Wind (mph)	**0-10**	**15-20**	**1.5 - 8**
20-ft wind (mph)***	**0-20**	**30 - 40**	**3 - 16**
*** National Weather Service (unpublished) ** Western Regional Climate Ctr http://www.wrcc.dri.edu/wraws/hiF.html *** Assumes eye level wind = 20-foot wind x 0.5 wind adjustment factor**			

On the day of the burn, the Army's Burn Boss appears to have been operating under a prescribed burn plan containing prescription parameters different than those specified in the 2002 Prescribed Burn EA. On August 4, 2003, the U.S. Army Burn Boss provided the Service with a briefing package (U.S. Army Garrison 2003b), in which he presented the prescription he had used on the July 22 burn (Figure E 6).

FIRE PRESCRIPTION:

	HOT (Dry)	DESIRED RANGE	COOL (Wet)
Dry Bulb Temp (F°)	85	55-90	65
Relative Humidity (%)	40	50-80	60
1-Hour Time Lag (%)	5	7-25	20
10-Hr Time Lag (%)	N/A		
100-Hr Time Lag (%)	N/A		
Mid-Flame Wind Speed	10mph	2-15mph	

Figure E 6. Image from Army handout (U.S. Army Garrison, August 4, 2003).

The Service and the Army recognize that the specifications of prescribed burn prescriptions are technical. Beginning in November 2006, the Army has invited a Fish and Wildlife Biologist with Prescribed Fire Burn Boss qualifications to each Army prescribed burn to assist the Army's Burn Boss with fire weather and suppression resource tracking. Since November 2006, two prescribed burns occurred at Makua (March 9, 2006 and December 6, 2006), and both burns were conducted in accordance with the agreed upon prescriptions (D. Greenlee, Service, pers. comm. 2006).

The Army provided the Service with a summary of additional factors which contributed to the escape of the 2003 prescribed burn. According to Army Fire Chief Gayland Enriques (pers. comm. 2005), a spot fire that ignited outside the firebreak road a short distance from an engine was not successfully suppressed by the engine crew and the two on-site Blackhawk fire suppression helicopters. A diurnal wind shift that was not mentioned in the Spot Weather Forecast, appears to have caught the Army fire managers by surprise and, in conjunction with their firing pattern, appears to have contributed to multiple areas of fire spread within the burn unit and multiple spot fires outside the firebreak road (Honolulu Advertiser 2003; G. Enriques, pers. comm. 2005; M. Mansker, U.S. Army, pers. comm. 2006). At a point when the spot fires were almost contained, the helicopters ran low on fuel and had to leave the fire to return to Wheeler Army Airfield for fuel. A CH-47 responded from Wheeler Army Airfield to assist with the suppression effort, but poor communications slowed the helicopter's response time (G. Enriques, pers. comm. 2005).

Analysis of Fire Risk

Fire risk zones were delineated to assign the baseline risk to endangered species and critical habitat occurring within the action area in the absence of the new firebreaks and fuelbreaks and skilled application of new Makua fire suppression staffing guidelines.

<u>High Fire Risk Zone</u> We designated the area mapped within the perimeter of historic wildland fires (see Figures E 1 and E 3) as the high fire risk zone (Figure E 7). There is a

greater risk that endangered plants growing within this zone will be burned within the next 30 years, unless they are located behind protective firebreaks and fuelbreaks.

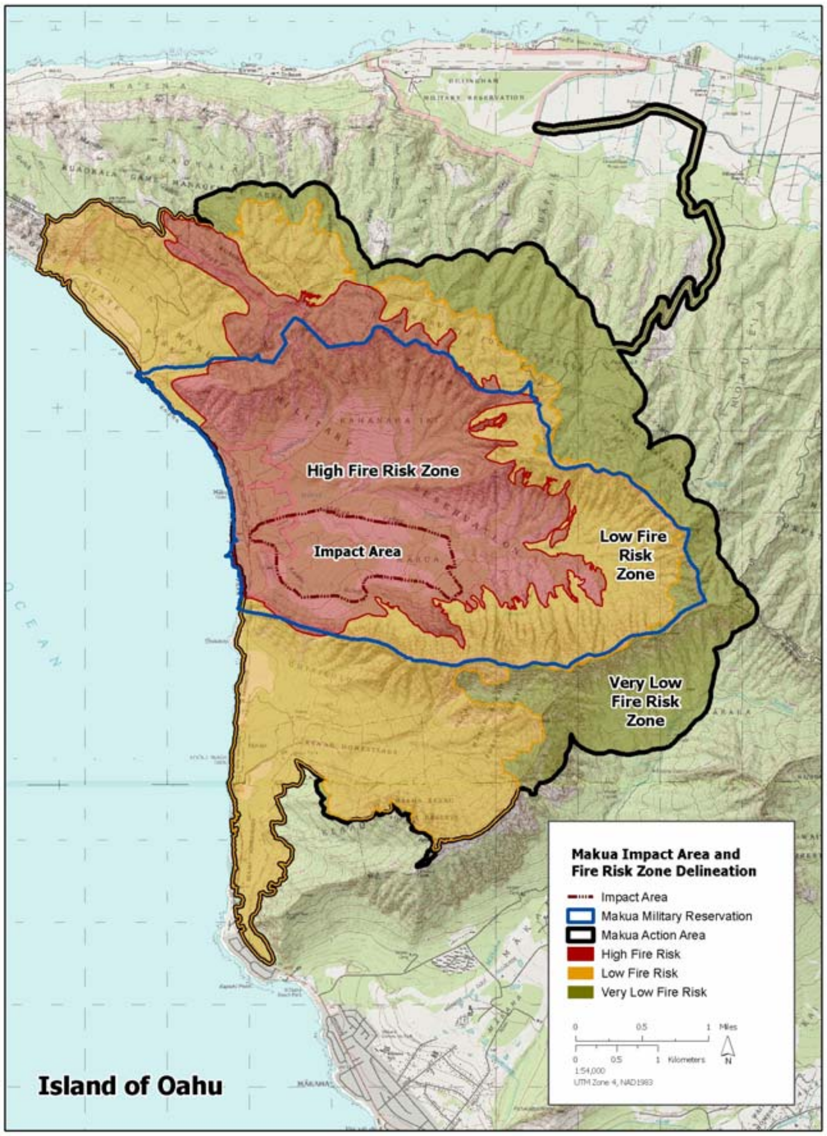


Figure E 7. Fire risk zones within Makua action area.

Low Fire Risk Zone Fires ignited within grass areas in Makua Valley may grow large enough to burn into existing forest vegetation outside of the perimeters of historic wildland fires. This may occur for several reasons: (1) fires unrelated to training, (e.g., fires caused by remnant white phosphorus rounds may occur when the range is not staffed by fire suppression forces); (2) fires occurring outside the firebreak road when live herbaceous fuel moisture is less than 100 percent may have large acreages in high wind conditions; (3) a level of fire suppression equipment malfunction and human error that is not factored into fire suppression staffing requirements may result in larger fires than anticipated. These factors put endangered species and critical habitat adjacent to the high fire risk zone at risk of burning.

In some areas of the valley, the forest – grass ecotone does not appear to have shifted since 1977 (the earliest available aerial photograph), however, in specific areas of the valley, these escaped fires resulted in conversion of forested areas to grassland. The northeastern edge of Kaluakauila is one area where this loss of forest occurred (Figures E 8 and E 9).

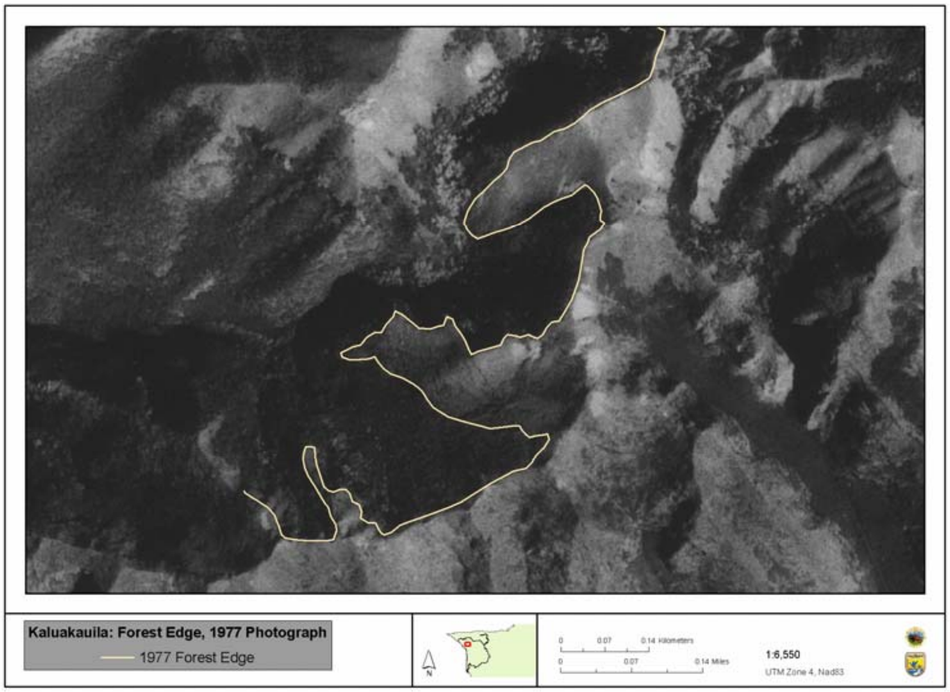


Figure E 8. Kaluakauila forest edge in 1977.

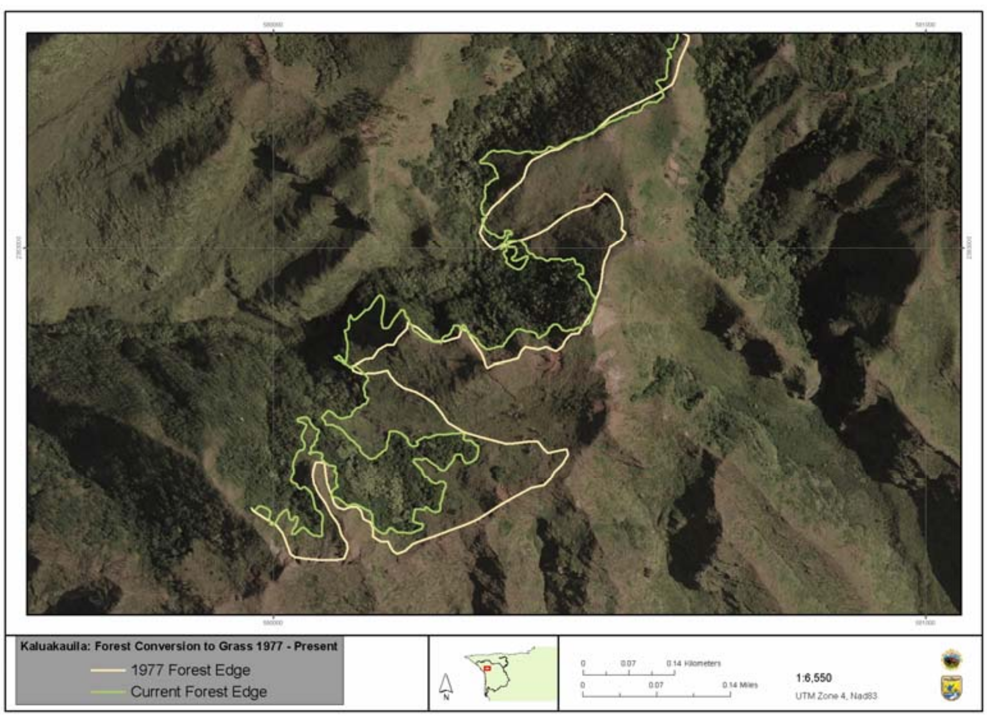


Figure E 9. Kaluakauila forest edge today, compared with its location in 1977.

We do not have a model that adequately predicts the locations of the actual future patches of habitat loss within the low fire risk zone. To delineate the area where the potential impact could occur, we ran a FARSITE fire spread model using three of the worst weather periods on record since 1999 (Aug 3-5 2000, Aug 9-11 2000 and Aug 17-19 2003) to predict the maximum extent of spread for fires from three ignition points within the valley burning for 48 hours. The outer perimeter of the compilation of all FARSITE simulations was designated as the outer perimeter of the low fire risk zone (Figure E 10).

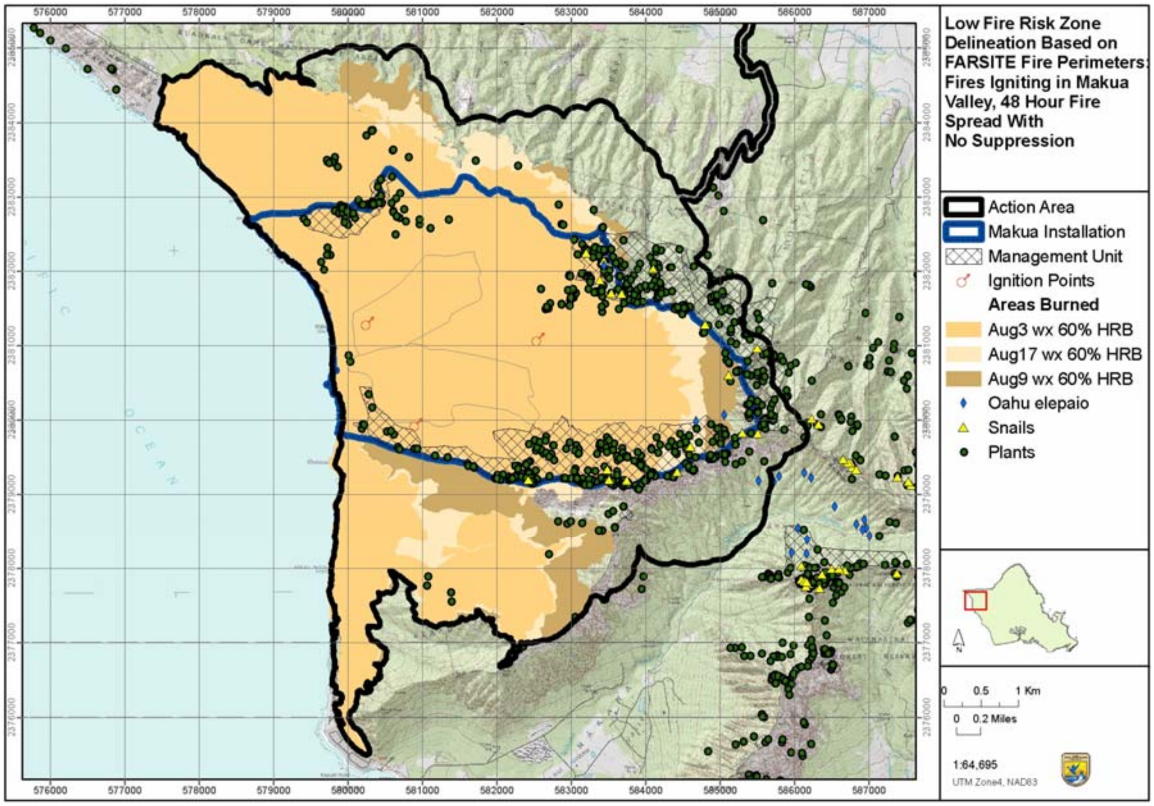


Figure E 10. Low fire risk zone delineation was based on the perimeter of fires burning in FARSITE for 48 hours with no suppression.

It should be noted that discontinuous and patchy fuels growing on rocky cliffs are poorly represented on the two dimensional, rough scale fuel model map. Therefore, FARSITE overpredicts rate of spread in cliff areas such as the cliffs in Ohikilolo Management Unit, where vertically discontinuous fuels will preclude fire spread. Locations of endangered species and patches of critical habitat growing in small protected areas such as cliffs are analyzed in relation to their individual fire risk in the effects analysis section. Plants growing on rock cliffs with discontinuous fuel are at risk of being burned by fires caused by weapons capable of landing directly on the site where the individual occurs. Grass fuels were assumed to not be grazed. Grazing is likely to limit fire spread in many patches of fuel in the areas south of the Makua.

Very Low Fire Risk Zone and Action Area Determination The Javelin and TOW both have the potential to land outside the Makua installation boundary, and spot fires from fires inside the valley may be ignited approximately 1.3 km (0.8 mi) from the fire front (Table E 4). Although the TOW carries an inert concrete warhead, remnant heat from the propellant burning in its motor can ignite a fire when the errant warhead impacts. The area where the errant TOW missiles are expected to land is bounded by the TOW surface danger zone. The chance of the TOW falling outside this area is less than 1:1million. A 1:1 million surface danger zone is also defined for the Javelin impact areas. To determine the area that may be burned by a fire ignited by a malfunctioning or misfired TOW or Javelin, FARSITE was run using the same three periods of wind and weather data as in the previous section, but because the TOW and Javelin will not be fired unless live herbaceous fuel moisture is 100 percent or higher, the following live fuel moistures were used for these simulations: 150 percent (fuel models 161, 182, and 188), 110 percent (all other fuel models). Fires were ignited along the entire outer perimeters of the TOW and Javelin potential ignition areas and allowed to grow, with no suppression, for 48 hours (Figure E 11).

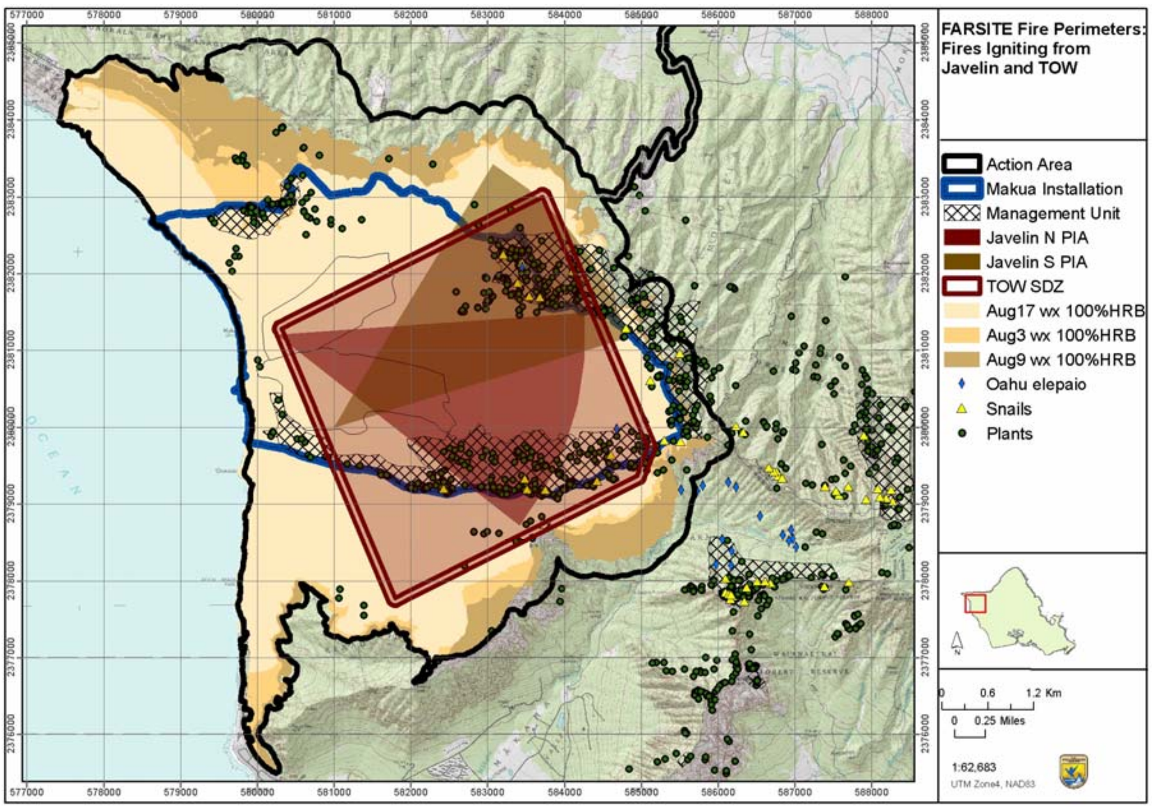


Figure E 11. Very low risk fire zone, based on areas burned after 48 hours in FARSITE simulations from fires ignited along the perimeters of Javelin and TOW potential ignition areas.

The very low fire risk zone and the outer perimeter of the action area were delineated by adding a 200-m (656-ft) buffer to the perimeter of the areas burned in the FARSITE simulations in areas that have not already been converted to grasslands to account for the future "creep" zone which may occur if forested areas are not restored prior to a subsequent fire event (see Figures E 8 and E 9). If grass invasion is not controlled in a burned site, a subsequent fire will burn a larger area, burning the forested area on the other side. This additional area also corresponds to the maximum spotting distance (the maximum distance a firebrand may be expected to ignite a fire given west wind conditions and a large fire burning within the heavy grass fuels in high fire risk zone).

Measures to Minimize Fire Risk

Prescribed Burning Risk Minimization Measures Burns conducted in conformance with the specifications outlined in the Makua 06-03 Prescribed Burn Plan will not occur when live herbaceous fuel moisture is lower than 100 percent. Fire behavior in guinea grass appears to be a factor of the greenness, or live herbaceous fuel moisture, of the grass. Although the layer of dead grass in the understory can support fire spread year-round (P. Costales, pers. comm. 2006), fire behavior appears to be substantially reduced during periods when the standing grass contains a substantial component of green leaves with high moisture contents. Much of the heat of any fire burning through a stand of green grass is absorbed by the water in the grass, slowing the rate of fire spread. Guinea grass growth and grass greenness appear to be closely related to soil moisture. Consequently, during wet months a high proportion of the standing grass leaves are green and the fuel moisture in those green leaves is high. During dry summer months only a few of the leaves in the grass stand are green and the rest of the leaves are either standing dead or they are alive but with very low fuel moisture contents. In the summer, when the majority of the stand is brown, this plant appears to produce a few fresh, green leaves following substantial rainfall events. The WIMS uses the NFDRS algorithm for calculating live herbaceous fuel moisture based on precipitation.

This live herbaceous fuel moisture stipulation has been applied successfully to two burns at Makua since March 2006 (March 8 and December 6, 2006; Figure E 12). In preparation for both of these burns, the vegetation in the burn unit was pre-treated with herbicide so that it would carry fire more readily under the cooler burning conditions specified by the prescribed burn prescription. Although the herbicide pre-treatment is not compulsory, in instances where the objective is a clean, continuous burn pattern, herbicide may be used to ensure that burn treatment objectives can be met.

Figure E 12. March 8 (left) and December 6, 2006 (right), burns conducted when live herbaceous fuel moisture outside the burn unit was greater than 100 percent and grass inside the burn unit (left center in both photos) had been pre-treated with herbicide.

The Makua 06-03 Prescribed Burn Plan specifies various 1-hour fuel moisture cutoff levels, depending on live herbaceous fuel moisture and fire suppression helicopter staffing. The probability of a firebrand igniting vegetation, given that it is generated, remains lit, and lands on receptive fuel, varies as a function of 1-hour fuel moisture. Long-range spotting may occur on prescribed burns or wildfires when convection columns loft burning embers from shrubs long distances (Table E 4).

Table E 4. Firebrand Probability of Ignition in Relation to One-Hour Fuel Moisture Percent and Long-Range Spotting Distance at Various Wind Speeds.

1-hour Fuel Moisture %	**Firebrand Probability of Ignition ***
4%	79%
5%	69%
6%	61%
7%	53%
8%	46%
9%	40%
10%	35%
11%	30%
12%	26%
13%	22%
14%	19%
15%	16%
16%	14%
17%	12%
18%	10%
19%	8%
20%	7%
* Assuming zero shading and 95 degrees F	

20-foot wind speed (mph)	**Maximum Spotting Distance**	
	(Miles)	**(Meters)**
0	0 mi	0 m
2	0.1 mi	161 m
4	0.2 mi	322 m
6	0.3 mi	482 m
8	0.3 mi	482 m
10	0.4 mi	644 m
12	0.5 mi	805 m
14	0.5 mi	805 m
16	0.6 mi	965 m
18	0.7 mi	1126 m
20	0.8 mi	1287 m

The Makua 06-03 Prescribed Burn Plan specifies an appropriate Maximum Manageable Area for spot fire occurrence. The burn plan is designed to prevent a spot fire from burning within any area of designated critical habitat or within any management unit (Figure 7 in Appendix D). The Makua 06-03 Prescribed Burn Plan specifies that if a spot fire burns any area of designated critical habitat or any shrub or forest area within a management unit, the site will be restored pursuant to the specifications required for restoration of a training-related fire in these areas. The prescribed burn plan is limiting the risk of spot fire occurrence by limiting ignitions to periods when live herbaceous fuel moisture is 100 percent or greater.

The plan specifies adequate on-site and standby fire suppression helicopter response to contain spot fires so that they will not burn into management units or designated critical habitat areas. The maximum spot fire size predicted by the CONTAIN module of BehavePlus for a fire burning in heavy guinea grass fuels on a 60 percent slope with an upslope wind under prescribed weather conditions is 36 ha (88 ac).

To avoid having multiple fire fronts within the burn unit, in 2006, the Army began implementing firing sequences, which enables the burning portion of the unit to be partitioned from the unburned area with aerial water drops if conditions become unfavorable. In 2006, pursuant to a recommendation by the Service, the Army began requesting more detailed spot weather forecasts from the National Weather Service. Spot weather forecasts received by the Army in 2006 included forecasted conditions for each hour of the burn day and included a narrative of expected diurnal wind shifts (N. Rydelle, National Weather Service, pers. comm. 2006).

A new internet and telephone system has been installed at Makua. During prescribed burns, internet and telephone lines are set up in a command post so that fire personnel have direct communications with contingency helicopter dispatchers. The Army is able to provide all personnel on prescribed burns with Army radios, so that local radio communications among interagency resources are excellent. However, the Makua area does not appear to be serviced by a repeater, so radio communications between the Makua area and the Garrison Command Center is incomplete (K. Kawelo, pers. comm. 2006).

<u>Live-Fire Training Fire Risk Minimization Measures</u> Weapons restrictions based on the burning index are expected to reduce the risk of wildland fire associated with the use of various weapons systems at Makua, in comparison with historic fire risk. Data analysis conducted by the Army indicates that the burning index frequency distribution varies with climate patterns such as El Niño and La Niña. Burning index data for January through August 2006 is shown in Table E 5. February and March 2006 were wet months and fire danger was low on a high percentage of hours on many days of these months. Table PD 3 in the Project Description summarizes actual range use anticipated, given the weapons restrictions which will be applied.

Table E 5. Frequency Distribution of Green, Yellow, and Red Fire Danger Ratings at Various Times of Day in January through August 2006.

Green/Yellow/Red Burning Index at Makua January - August 2006								
	Percent of Days							
Time	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
6:00 AM	37%	43%	90%	43%	30%	37%	17%	13%
	50%	43%	13%	57%	73%	57%	73%	70%
	17%	7%	0%	0%	0%	7%	13%	20%
9:00 AM	33%	33%	90%	23%	17%	3%	3%	0%
	47%	47%	13%	73%	60%	63%	53%	47%
	23%	13%	0%	3%	27%	33%	47%	57%
1:00 PM	10%	27%	70%	10%	10%	0%	3%	0%
	53%	43%	33%	67%	43%	53%	33%	43%
	40%	23%	0%	23%	50%	47%	67%	60%
6:00 PM	20%	40%	83%	10%	7%	0%	10%	3%
	50%	40%	20%	87%	57%	37%	30%	33%
	33%	13%	0%	3%	40%	63%	63%	67%
9:00 PM	23%	27%	87%	27%	17%	7%	13%	7%
	57%	50%	17%	73%	77%	77%	57%	67%
	23%	17%	0%	0%	10%	17%	33%	30%
1:00 AM	37%	37%	97%	50%	33%	10%	13%	13%
	53%	43%	7%	47%	67%	80%	67%	73%
	13%	13%	0%	3%	3%	10%	23%	17%

Although 2006 had a very wet spring, the data indicates that unless it is raining, the occurrence of Green fire danger rating conditions is very limited in the summer and in the afternoons in the winter.

On-site and 1-hour standby fire suppression helicopter staffing is sufficient to suppress fires under 97th percentile fire weather conditions (Table E 6 and see Table PD 11), even though no training will be occurring on the days with the highest fire danger. Analysis of historic fire danger archives and FireFamily Plus calculations for summer conditions (live herbaceous fuel moisture lower than 100 percent) indicates that, on approximately 37 to 50 percent of those 97th percentile fire weather days, the fire danger rating calculated for all hours of daylight were Red. Therefore, we anticipate the Incident Commander will need to dispatch the contingency (two-hour response time) helicopters on only one and a half percent of the training days.

Analysis of the 34 recorded training-related fires that have burned outside the firebreak roads at Makua indicates that it took an average of 53 minutes to suppress fires ignited in Green fire danger conditions and an average of 2 hours and 16 minutes to suppress fires ignited under Yellow fire danger conditions. Therefore, when staffing fire suppression aircraft for training exercises at Makua, staffing will be based on wind speeds predicted during the training period as well as during periods following training, to ensure that fire suppression staffing is sufficient to suppress a fire ignited at the end of the training period.

Table E 6. Frequency Distribution of Makua Fire Weather conditions at 1 p.m. in the Winter and Summer.

November through March, 1 p.m. 1-hour fuel moisture and wind speed Joint Probability (%) for all available 1999 - 2006 Weather Data, Fire Danger Rating Colors Based on Live Herbaceous Fuel Moisture 100%, Live Woody Fuel Moisture 100-170%

20-ft wind	1-hour fuel moisture					
	< 6%	6-7%	7-9%	9-11%	11-13%	>13%
0-1 mph	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%
1-3 mph	0.11%	0.11%	0.86%	1.40%	0.54%	0.11%
3-5 mph	0.65%	1.83%	7.63%	5.05%	0.75%	0.54%
5-7 mph	0.65%	2.15%	15.81%	6.24%	0.32%	0.43%
7-9 mph	0.54%	2.26%	9.14%	3.01%	0.65%	0.86%
9-11 mph	0.00%	1.61%	5.70%	3.12%	0.11%	0.00%
11-13 mph	0.11%	0.97%	4.09%	2.04%	0.43%	0.43%
13-15 mph	0.43%	1.83%	4.62%	1.18%	0.43%	0.22%
15-17 mph	0.32%	1.08%	3.01%	0.86%	0.75%	0.22%
17-18 mph	0.00%	0.43%	0.75%	0.43%	0.11%	0.00%
18-19 mph	0.00%	0.11%	0.32%	0.22%	0.00%	0.11%
> 19 mph	0.00%	0.32%	0.97%	0.75%	0.22%	0.00%

June through September, 1 p.m. 1-hour fuel moisture and wind speed Joint Probability (%) for all available 1999 - 2006 Weather Data, Fire Danger Rating Colors Based on Live Herbaceous Fuel Moisture 60%, Live Woody Fuel Moisture 60-130%

20-ft wind	1-hour fuel moisture					
	<6%	6-7%	7-9%	9-11%	11-13%	>13%
0-1 mph	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1-3 mph	0.00%	0.00%	0.81%	0.48%	0.16%	0.16%
3-5 mph	0.00%	0.32%	1.94%	1.45%	0.48%	0.16%
5-7 mph	0.00%	1.62%	11.79%	4.52%	0.97%	0.48%
7-9 mph	0.48%	2.91%	14.54%	3.23%	0.32%	0.16%
9-11 mph	2.42%	3.07%	7.11%	2.58%	0.16%	0.16%
11-13 mph	2.10%	3.88%	5.01%	1.45%	0.48%	0.32%
13-15 mph	2.58%	3.72%	3.88%	0.97%	0.16%	0.32%
15-17 mph	1.29%	2.42%	3.39%	0.32%	0.00%	0.00%
17-18 mph	0.32%	1.29%	0.97%	0.32%	0.00%	0.00%
18-19 mph	0.65%	0.00%	0.48%	0.16%	0.00%	0.00%
>19 mph	0.16%	0.48%	0.32%	0.00%	0.00%	0.00%

Proposed weapons restrictions based on live herbaceous fuel moisture are expected to reduce fire ignitions as well as fire size and risk of fire escape. When live herbaceous fuel moisture is less than 100 percent, tracers, 2.75-caliber rockets, Javelin, and TOW missiles will not be used; AT-4 and SMAW will only be used in Green fire danger conditions; and prescribed burning will not be conducted. Historic analysis of live herbaceous fuel moisture trends indicates that live herbaceous fuel moisture is expected to be 100 percent and above on most days between approximately mid-October and mid-February and early-May. Fires outside the firebreak road are not expected to be larger than 40.5 ha (100 ac) when live herbaceous fuel moisture is 100 percent or higher (see Table PD 11). Summer fires may be much larger. To protect the management units from summer fires and weapons fires ignited well away from the interior of the south lobe of the firebreak road a system of firebreaks and fuelbreaks adjacent to the management units and a pre-attack plan for staffing the management unit firebreaks with skilled firefighters during large fire events is included in the Project Description.

Sufficiency of Firebreaks and Fuelbreaks

Firebreak Roads The 60 meters of mown grass inside the perimeter of the south lobe of the firebreak road is expected to prevent all fires from slopping over the firebreak road and prevent most short-range spot fires from igniting fires outside the impact area. In the absence of spotting, the suggested firebreak width required to stop the head fire itself is approximately one and a half to two times the flame length (Byram 1959; Wilson 1988; Fogarty and Alexander 1999). Beavers recorded maximum flame lengths of 14 m (45 ft) in test burns at Schofield Barracks (Beavers 2001) in guinea grass with live herbaceous fuel moisture that FireFamily Plus calculations indicate were approximately 90 to 100 percent.

The onset of significant spotting activity is generally acknowledged to occur at fire intensities of approximately 1,500-2,000 kW/m (500-667 Btu/ft/s) (Taylor and Wendel 1964; Hough and Albini 1978; Hirsch et al 1979). Beavers' (2001) GRASS2 fuel model and the updated version of this fuel model (see Project Description Section 9) both indicate that under the proposed training conditions, guinea grass fire intensity is generally below this threshold under average daily burning conditions when live herbaceous fuel moisture is greater than 120 percent, and it is likely to exceed this threshold when live herbaceous fuel moisture is below 100 percent. Therefore, short-range spotting is expected to be common in fires when live herbaceous fuel moisture is below 100 percent. Long-range spotting up to approximately 1,288 m (0.8 mi) may occur, particularly under higher wind conditions on warmer days and on larger fires with developed convection columns. The presence of koa haole shrubs increases the likelihood of firebrands and spot fires. This shrub appears to colonize sites that are not burned or mowed frequently. Large firebrands will not be produced by a fire burning in the mowed grass area, and fire intensity and flame length will be substantially reduced (Fogarty and Alexander 1999).

Sixty meters (197 ft) separation between heavy grass fuels and koa haole shrubs is expected to minimize spot fire risk, based on the spatial distribution of short-range spot fires documented in guinea grass fires. Spot fires have been observed at the following distances in front of free-burning guinea grass head fires: many spot fires 15 m (50 ft), several spots approximately 30 m (98 ft), some spot fires as far as 50 m (164 ft) (D. Greenlee, pers. comm. 2007). Fuels are reduced to various widths adjacent to firebreaks to limit the number of spot fires igniting fires on the other side of the firebreaks. Wright (1974) recommends a 30 m (100 ft) wide fuelbreak in light rangeland grass fuels. Davis (1965) found that there is a 21 to 50 percent chance of stopping forest fires burning under extreme burning conditions with a 107-m (350-ft) wide fuelbreak and a greater than 50 percent chance of stopping them with a 305-m (1,000-ft) wide fuelbreak. Long-range spotting, resulting from larger firebrands lofted by large convection columns and by fires in high wind conditions, are predicted by BehavePlus (Table E 4). When large fires develop inside or outside the firebreak roads, long-range spotting may occur at Makua.

Kaluakauila Management Unit Protection The endangered species and designated critical habitats within the Kaluakauila Management Unit are within the high fire risk zone. There are only approximately 26 ha (65 ac) of shrub and forest vegetation remaining in this management unit. Five hectares (12 ac) of intact shrub and forest within the management unit perimeter appear to have been lost as a result of wildland fires between 1970 and 2006. The 1970 and 1984 wildland fire perimeter maps indicate that these fires burned around all edges of the intact forest in this area and 1995 and 2003 escaped prescribed burns both consumed shrubs along the perimeter of the intact forest in this management unit (see Figures E 8 and E 9). Accidental and arson fires ignited on State land adjacent to the beach below the management unit have burned into the lower portions of the site (U.S. Army 2006b). The management unit contains *Abutilon sandwicense* (22 plants, 8 percent of total), *Bonamia menziesii (*10 plants out of 28 on Oahu – thousands on other islands), 199 *Euphorbia haeleeleana* (31 percent of total), an *ex situ* population of *Hibiscus brackenridgei* ssp. *mokuleianus*,124 *Melanthera tenuifolia* (4 percent), 31 *Neraudia angulata* var. *angulata*, 230 *Nototrichium humile* (in addition to the 323 on south aspect outside management unit equals 553 (44 percent of total)), and *Schiedea hookeri* (92 plants, 22 percent of total, non-stabilization plant) and designated critical habitat for *Bonamia menzeisii*, *Chamaesyce celastroides* var *kaenana*, *Euphorbia haeleeleana*, *Nototrichium humile*, and *Schiedea hookeri*. A fire in the intact forest in this area would result in substantial losses.

Extraordinary measures will be necessary to ensure the future persistence of this patch of forest. The site is likely to be threatened by large Army-related fires and fires ignited by the public, particularly when live herbaceous fuel moisture is below 100 percent. The Army is proposing to prepare a 6-ha (15-ac), 20-m (66-ft) wide strategic fuelbreak with an integrated firebreak along the southern perimeter of the intact forest vegetation and to work with the State to establish and maintain fuelbreaks below the site. The ridge-top firebreak/fuelbreak combination is expected to halt the spread of fires burning up from Makua Valley, but spot fires are likely to ignite in the grass fuels north of the fuelbreak. The Service is relying heavily on the Army Incident Commander's recognition that this site requires the highest priority for assignment of fire suppression helicopter and ground resources. Representatives from the Service and the Army Wildland Fire Management Officer and wildland fire crew have visited Kaluakauila and worked closely to develop the plans in this Biological Opinion. The Army has hired skilled fireline supervisors and is developing supervisory skills within their crew to prepare them to supervise Kaluakauila Management Unit fire suppression operations. Helispots and safety zones will be established and maintained to ensure that rapid and safe deployment of fireline supervisors and firefighters to the site can be completed. Because of the small size of the forest patch (only approximately 1,000 m (3,280 ft) or 50 chains of exposed southern perimeter) compared with the substantial fire suppression helicopter staffing that will be assigned when live herbaceous fuel moisture is below 100 percent (i.e., 98 to 270 chains/hour assigned fire suppression capability), it will take all assigned fire suppression helicopters between 12 and 32 minutes to completely extinguish a fire threatening the southern edge of this forest if all helicopters were directed to protect this site. We believe that the measures proposed are appropriate and adequate to ensure the protection of the endangered species and critical habitats occurring within the Kaluakauila Management Unit from Army-related wildland fire.

Kahanahaiki Management Unit Protection   The Army will be establishing a fuelbreak to reduce the risk of fire to the slopes below the Kahanahaiki Management Unit. However, because fire frequency is expected to be high in this area of the valley, and because the fuelbreak is not very wide (40 m;131 ft) and will be established mid-slope, spot fires may burn into areas designated as critical habitat for the Oahu elepaio and into sites where endangered species occur. The specific risk to particular individuals will depend on their location in relation to previously burned areas that have been converted to grass. Spot fires and fires ignited by Javelin and TOW missiles may also occur within intact forest vegetation. The perimeter of the site is only 500 m (1,640 ft) or 25 chains. Given that future Army Incident Commanders are expected to have a thorough understanding of the critical importance of minimizing fire impacts to this area, we anticipate that Incident Commanders will be able to ensure the protection of this relatively small area from substantial fire losses by strategically utilizing their assigned fire suppression helicopters.

The lower reaches of the Kahanahaiki gulch and the south aspect of the upper reaches of the gulch burned in the 1970, 1984, 1995, and 2003 wildfires. All of these fires except for the 1984 fire breeched the Kahanahaiki Management Unit perimeter in this gulch area. The Army will construct either a 20-m (66-ft) wide firebreak, or a 200-meter (656 ft) wide shaded fuelbreak on the south aspect of Kahanahaiki gulch at the Kahanahaiki Management Unit perimeter fence line. The perimeter firebreak and fuelbreak are both well-designed and located at the crest of a small ridge where they are likely to successfully halt the spread of fires. However, if a spot fire does burn into the area, much of the Kahanahaiki gulch area is on a north aspect with intact forest vegetation where firefighters can patrol to direct helicopter bucket drops and use hand tools to protect the forested areas and endangered plant sites from fire. A helispot will be maintained within 500 m (1,640 ft) of the upper reaches of Kahanahaiki gulch, and a safety zone will be established within or adjacent to the management unit so that skilled NWCG-qualified fireline supervisors and firefighters, including red-carded Army Natural Resources staff, can safely staff the outplanting site when fire threatens the gulch area. These efforts are likely to minimize losses of endangered species in the Kahanahaiki area.

Ohikilolo Cliffs   Fire suppression helicopter staffing is sufficient to suppress a fire ignited by a TOW in shrub or forest fuels at 0.12 ha (0.3 ac) or less, even if the fire ignites on a 60 percent slope with upslope winds of 18 mph and 1-hour fuel moisture of six percent. If a TOW fire ignited in the shrub/forest fuels burns undetected for 48 hours, it could grow to more than 40.5 ha (100 ac). One-hour fire detection flights will be flown by the Army Wildland Fire Incident Commander and, if there are multiple on-site helicopters, by additional firefighters, following the use of a TOW missile. If a TOW fire occurs in the shrub/forest vegetation, the proposed fire detection and fire suppression staffing protocols will minimize the risk of damage and fire spread.

General Effects of Army Conservation and Stewardship Programs

Subsidies associated with the proposed action include measures to minimize project impacts through various aspects of the Makua Integrated Natural Resource Management Plan, Wildland Fire Management Plan, and Makua Implementation Plan Addendum. Implementation of the Integrated Natural Resource Management Plan and Wildland Fire Management Plan will reduce the exposure of listed resources to stressors associated with the ignition and spread of training-related wildfire. Implementation of the Makua Implementation Plan Addendum will benefit target taxa through habitat protection and restoration, control of invasive species, and augmentation and reintroduction of listed species in the wild. The response of listed resources will be an overall increase in baseline numbers due to increases in individual fitness and population unit viability. Fitness and viability will improve as a result of reduced fire injury and death; increased survival and regeneration due to reduced competition, predation, and herbivory; and increased numbers of target plant taxa due to outplanting. As a result, these programs will improve the likelihood that target taxa reach stabilization and enhance their probability of long-term persistence. It is the Service's biological opinion that the impacts of the proposed action would be of great concern over the next 30 years without implementation of the Army's conservation and stewardship programs.

The INRMP, Wildland Fire Management Plan, and Makua Implementation Plan Addendum are regular budget items for Army training at Makua. Therefore, the Service analyzes the effects of the proposed action based on the reasonable expectation that these proposed minimization measures will be successfully implemented. However, constraints associated with implementation of these programs could delay their effectiveness in protecting listed resources and stabilizing target taxa. For example, the effectiveness of the Wildland Fire Management Plan has not been tested under intensive training conditions with tracers and other long-range, high-fire-risk weaponry never before used at Makua (e.g., 155 mm high-explosive artillery, TOW missiles, Javelin missiles, and 2.75-caliber rockets). In particular, the Army's proposed improvements in firefighting capacity (e.g., increased numbers and effectiveness of on-site helicopters) do not guarantee that fire risk to listed resources will be eliminated. Reduction in wildfire ignition and spread may not succeed to the extent anticipated due to inadequate fuels management or revegetation of burned areas, for which the Army has not yet developed plans or schedules. Monitoring the results of Wildland Fire Management Plan implementation in reducing fire risk over the next 30 years will provide valuable information on the efficacy of these minimization measures.

Implementation of Addendum stabilization actions also does not guarantee that target taxa will be stabilized over a specified timeframe. Therefore, because of uncertainty regarding the timely success of project conservation and stewardship programs, the Service is unable to determine that target taxa will reach stabilization before a castastrophic wildfire occurs in the action area over the next 30 years. Expedited stabilization of the most at-risk plant taxa is intended to protect those taxa from jeopardy while long-term Wildland Fire Management Plan and Makua Implementation Plan Addendum actions are being implemented.

Burned Area Restoration

The Army has proposed that they will restore any portion of critical habitat that is lost during a training related fire event. This measure will offset the adverse impact to critical habitat due to fire. However, as previously discussed in other sections in this general effects section, alien plant species in Hawaii are aggressive, adaptable, numerous and can outcompete native plant species for space, light, and nutrients. It will be expensive and difficult to restore a burned area to pre-burn conditions but not impossible.

While habitat restoration poses many challenges, there have been successful restoration or “rehabilitation” projects in Hawaii. Thousands of acres of dryland forest have been lost to fire at Hawaii Volcanoes National Park during the last few decades. The park managers have had to address the loss of woodland tree species and the subsequent habitat degradation as non-native grasses replaced native tree species. To combat this problem, the managers adopted a rehabilitation approach to create a replacement community of fire-tolerant native plants that can survive and spread in the new grass/fire cycle. After a devastating burn (407.9 ha; 1,008 ac) in June 2000, a Burn Area Emergency Rehabilitation program started revegetating the area days after the fire. More than 15,000 plants and 3,000,000 seeds of 23 native species have been planted including thousands of mamane (*Sophora chrysophylla*) trees and alii (*Dodonaea viscosa*) shrubs as well as rare kookoolau (*Bidens hawaiensis*) and naupaka (*Scaevola kilaueae*) plants. By June 2003, the project goal will have planted 31 native species, including 15 fire-tolerant species that were established through a combination of direct seeding and outplanting into 850 plots across the entire burn area (Loh and Tunison 2002).

Another project on the island of Hawaii began in 1995 and included a study regarding the preservation and restoration of a Hawaiian tropical dry forest. This project is a 2.4 ha (6 ac) site on the dry slopes on the western side of the island and was infested with fountain grass (*Pennisetum setaceum*). After three years of herbicide spraying and hand removal of the fountain grass, signs of natural regeneration of native tree seedlings was evident (Allen 2000).

Integrated Natural Resource Management Plan

The Makua Integrated Natural Resource Management Plan specifies management of Army lands to ensure long-term natural resource productivity in support of the Army mission. The Integrated Natural Resource Management Plan incorporates an ecosystem-level approach to managing natural resources through inclusion of the ITAM, Range and Training Land, and Natural Resources programs. Integrated Natural Resource Management Plan activities also will indirectly expose listed resources in the action area to the introduction and spread of non-native, invasive plants through range revegetation and transport of weed propagules in vehicles, equipment and gear.

The ITAM program provides for the sustainable use of training lands by monitoring and remediating training impacts such as erosion and loss of vegetative cover. The ITAM program annually monitors the long-term carrying capacity of training lands, and prioritizes and evaluates land rehabilitation projects (U.S. Army Corps of Engineers 2005). Erosion problems are caused by ground disturbance from training activities, including detonation of munitions, troop activities in the training impact area, and troop use of installation trails. Remediation includes mulching, controlling runoff, rotating land uses, and revegetating heavily-used training areas by reseeding and hydroseeding with rapidly growing plants (including non-native species). The exposure area for the ITAM program is located primarily within the training impact area within the firebreak roads. The proposed action does not include erosion remediation measures for troop use of State lands on the Kaena Point and Kuoakala Trails (U.S. Army Corps of Engineers 2005). Listed resources throughout the action area will not be directly exposed to ITAM activities. Indirect exposure to ITAM subsidies will result from firebreak maintenance and fuels modification, which will reduce the risk of ignition and spread of training-related wildfire.

The Range and Training Land program provides for operation and maintenance of military training ranges through weapons delivery and target management, and regulates access to training areas and ranges. Subsidies associated with the Range and Training Land program include Range Safety, which is responsible for developing surface danger zones for all weapons systems and munitions used at Makua. Surface danger zones are weaponry restrictions for personnel safety. The area directly exposed to the Range and Training Land program includes the training impact area within the firebreak roads, and surface danger zones that in some cases extend across the valley floor outside the firebreak roads. Listed resources throughout the action area will be indirectly exposed to Range Safety activities that reduce the risk of projectiles landing outside the firebreak roads through development and enforcement of surface danger zones and NFDRS conditions.

The Natural Resources program manages rare plants and animals and their habitats to ensure the Army is in compliance with the Endangered Species Act and other environmental laws and regulations. This program is beneficial as it improves conditions for listed resources primarily by reducing or removing their exposure to stressors associated with non-native invasive species. Other subsidies are associated with stabilization of target taxa through implementation of the Addendum to the Makua Implementation Plan. The Makua Implementation Plan Addendum also includes phytosanitation standards for greenhouse and outplanting operations, and for maintaining clean equipment and personal gear. The major subsidies associated with the Natural Resources program are described in the General Effects of Endangered Species -Stabilization section.

The proposed action includes troop education and vehicle/equipment/gear cleaning measures to minimize the exposure of listed resources to the introduction and spread of non-native species associated with Integrated Natural Resource Management Plan programs. Phytosanitation measures are emphasized for all personnel, including troops, maintenance crew, and Natural Resources Staff. Education brochures and briefings are given to troops and to road and range maintenance crews to increase awareness and reduce introduction of weed seeds. There are wash racks at Pohakuloa Training Area and Schofield Barracks Military Reservation for cleaning vehicles that leave those installations, but none for vehicles entering Makua. Some weed species identified at Makua apparently originated from Pohakuloa Training Area on the island of Hawaii and their introduction may have been prevented by proper cleaning procedures. According to Army Natural Resources Staff, the provision of gear-cleaning infrastructure and use of phytosanitation procedures for military personnel at Makua is a “weak area” that “needs improvement” (U.S. Army Garrison 2005b).

General Effects of Endangered Species Stabilization

Stabilization Subsidies in the Makua Action Area

Project subsidies include existing and proposed conservation measures the Army will implement to stabilize 28 target endangered plant taxa and the Oahu tree snail *Achatinella mustelina*. Stabilization was the key component identified in the 1999 Makua consultation to minimize the impacts of military activities by increasing the baselines of target taxa, which otherwise would be jeopardized by military training in the Makua action area (Service 1999b, 2001b, 2004a). The Makua Implementation Plan incorporates stabilization objectives outlined in Service recovery plans, which are based on conservation actions recommended for recovery. The recovery plan goals are consistent with current conservation biology principles addressing the conservation of rare and endangered plants and animals (Ginzburg et al 1990; Menges 1990; Murphy et al1990; Karieva and Wennergren 1995; Taylor 1995; Tear et al 1995; Quintana-Ascencio and Menges 1996; Beissinger and Westphal 1998; Hendrix and Kyhl 2000; Luijten et al 2000; Burgman et al 2001; Podolsky 2001; Wolf and Harrison 2001; Groom et al 2006).

Achieving stabilization for target taxa will enable the Army to comply with the Endangered Species Act jeopardy standard by avoiding or minimizing actions that would reduce appreciably a species’ likelihood of both survival and recovery in the wild. Conservation measures the Army proposes to implement for listed plants and tree snails in action area management units also will benefit primary constituent elements of designated critical habitat, in areas where management unit boundaries overlap those of critical habitat. The Service reasonably expects that achievement of stabilization, including expedited stabilization for 12 at-risk taxa, will protect affected species from jeopardy. We also expect the Army will fully fund the Makua Implementation Plan Addendum actions, including actions associated with expedited stabilization and implementation of the Wildland Fire Management Plan, in order to train intensively with new weaponry in compliance with the Endangered Species Act.

We have determined that the effects of stabilization actions will be beneficial to the 28 target plant taxa and the Oahu tree snail *Achatinella mustelina* in the action area, and to the conservation value of critical habitat areas for 36 plant taxa and for the Oahu elepaio that overlap the management units delineated for stabilization. Stabilization actions implemented for the 28 target plant taxa also will benefit individuals and occurrences of 11 non-target taxa where they occur in the management units. Conservation actions to achieve stable threshold numbers for target plant taxa include fencing to exclude non-native feral ungulates; control of non-native ungulates, rats, invertebrates, and plants; outplanting to augment and reintroduce target plant taxa; collection of material for *ex situ* plant genetic storage; and captive propagation of *Achatinella mustelina* tree snails. Specific stabilization actions are outlined in Army’s Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) to the Makua Implementation Plan (Makua Implementation Team 2003). The Makua Implementation Plan was developed by the interagency Makua Implementation Team, which also monitors the Army's implementation of the plan and approves adjustments based on an adaptive management strategy.

In Hawaii, fencing to exclude ungulates is generally a prerequisite for restoration of native ecosystems (Cuddihy and Stone 1990; Scrowcroft and Conrad 1992; Stone et al 1992; Cabin et al 2000; Cabin et al 2002a). The response of native vegetation to ungulate exclusion appears to be related to many interacting plant, habitat, and microclimate variables, including the duration and intensity of prior habitat degradation (Stone et al 1992; Cabin et al 2002b). The proportion of native to non-native plant species, for example, remains low in lowland shrublands even after 13 to 15 years of recovery from goat damage. Few studies, however, have actually quantified the effects of ungulate exclusion on native plants. In the 2.3-ha (5.7-ac) Kaupulehu dry forest preserve on the island of Hawaii, for example, fencing has excluded feral ungulates for over 40 years. Vegetation is now more diverse, with a greater cover of native overstory and understory species. However, regeneration of native canopy trees such as *Diospyos sandwicensis* is poor because of dense fountain grass cover (*Pennisetum setaceum*) in the understory and predation by alien rodents (Cabin et al 2000; Cabin et al 2002a). Experience at Kaupulehu has shown that fencing alone is not sufficient to preserve native dry forest; ongoing control of non-native plants and animals is also needed for the regeneration and recruitment of native plants. Recovery of many Hawaiian ecosystems disturbed by ungulates will likely require ungulate exclusion, aggressive and continual alien plant management, lengthy recovery times, reintroduction of native plant species, and light and water supplementation where needed in dry forest zones (Stone et al 1992; Cabin et al 2000; Cabin et al 2002b).

Exclusion of feral ungulates may result in unintended adverse impacts to fire regimes in mixed native and non-native vegetation types. In some degraded dry habitats, the cover of alien grasses increases after ungulates are removed (Loope and Scowcroft 1985; Stone et al 1992; Blackmore and Vitousek 2000). For example, if grass cover is not controlled by grazing, fuel loads accumulate and may increase the possibility of catastrophic fire. Although cattle grazing in some mesic to seasonally dry forest habitats on the island of Hawaii resulted in less forest cover, it also protected the residual forest from fire by reducing fuel loads (Blackmore and Vitousek 2000). In addition, fire simulation models indicate fires are highly unlikely in grazed fuels (Blackmore and Vitousek 2000). Therefore, ungulate exclusion alone does not necessarily facilitate the recovery of native ecosystems threatened by alien grass fire regimes.

In the Makua action area, eight management units for ecosystem-level habitat management are located entirely or partially within the action area. Four management units on Makua proper are fenced (Kaluakauila, Lower Ohikilolo) or partially fenced (Kahanahaiki, Ohikilolo) and considered ungulate-free (U.S. Army Garrison 2006d). In addition, the installation boundary has been fenced along the east valley rim from the fenced Kahanahaiki subunit I to Ohikilolo. Partially within the action area outside of the installation boundary, the Pahole Management Unit is fenced and ungulate-free, but the Upper Kapuna, West Makaleha, and Kahanahaiki subunit II Management Units are not fenced. Fences also have been constructed around some of the management units not immediately adjacent to the action area, for example, in the privately owned Honouliuli Preserve.

Army Natural Resources Staff believe the Makua installation is free of goats, due to lack of sign along transects, lack of recent snare captures, and incidental observations by staff and contract hunters (U.S. Army Garrison 2006d). The fenced Kaluakauila Management Unit still offers some access to feral pigs, which seem to increase in numbers there during the strawberry guava fruiting season. In the Ohikilolo Management Unit, goats have contributed to serious erosion problems in the past. A perimeter fence at the installation boundary protects this management unit from large populations of feral goats in the adjacent Keaau Game Management Area and Ohikilolo Ranch. As a result of Army removal efforts, monitoring results since 2004 indicate that goats have been eradicated from this management unit. As long as fences are maintained and ungulate sign is monitored, exclosures seem to be effective in protecting native habitats from ungulate damage; however, fences are occasionally damaged by rockslides and fire. Overall, the Service considers the Army's fencing, control, and monitoring activities to be successful in excluding feral ungulates on Makua.

Feral pigs and goats are common on State, city/county, and private lands within and/or adjacent to the action area. Large goat populations occur in the Mokuleia Forest Reserve and other unfenced source areas, such as Schofield Barracks West Range, Mount Kaala Natural Area Reserve, and the Makaleha and Makaha areas (U.S. Army Garrison 2005b). For example, State personnel have removed about 240 goats from the Lower Kaala Natural Area Reserve since 2000. Small goat populations in the unfenced Upper Kapuna and West Makaleha management units may be able to access parts of the fenced Pahole Management Unit. Portions of The Nature Conservancy of Hawaii's Honouliuli Preserve, which encompasses several management units, is fenced, and pigs and goats are present in unfenced areas. The Makaha Management Unit, owned by the Honolulu Board of Water Supply, is not yet fenced. Both Honouliuli and Makaha areas support population units critical for stabilization and expedited stabilization of target and at-risk taxa. Army Natural Resources Staff is unable to manage ungulates in management units on State, city/county, and private lands on a consistent, ongoing basis without long-term cooperative agreements with landowners. Agreements have been reached between the Army and The Nature Conservancy of Hawaii and the Honolulu Board of Water Supply, but not with the State or other private landowners.

Rodents have been identified as a threat to listed and other native plants in the action area and are controlled in some management units by grids of toxicant bait stations and snap traps. Control grids are focused on areas managed for plant target taxa known to be sensitive to rodent predation. For example, rat control grids are managed in the West Makaleha Management Unit to protect occurrences of *Cyanea grimesiana* ssp. *obatae*, *Delissea subcordata*, and *Cyanea superba* ssp. *superba*, and in the Ohikilolo and West Makaleha Management Units to protect *Pritchardia kaalae* seedlings. In the Kahanahaiki Management Unit, rat control to protect nesting elepaio may also benefit *Cyrtandra dentata*. Rat control grids at elepaio nesting sites during the breeding season (January to June) are also managed in the action area in the Ohikilolo Management Unit and along the east valley rim. In addition, rats are controlled at two snail exclosures to protect *Achatinella mustelina* tree snails from *Euglandina rosea* predation. Outside the action area, rat control is conducted in the Ekahanui Management Unit to protect *Plantago princeps* var. *princeps* and Oahu elepaio nesting pairs, in the Waianae Kai Management Unit to protect *P. kaalae*, and in various other management unit locations on Oahu.

The Army controls the introduction and spread of non-native invasive plants within management units in the action area primarily through phytosanitation measures, surveying to detect and eradicate new weed species before they become established, and prioritizing weed control areas in management units. Surveys are regularly conducted to detect the introduction of new weed species along potential military introduction corridors (roads, helicopter landing zones) and along fence lines and ungulate-monitoring transects. Appendix 3.1 of the Makua Implementation Plan lists 31 priority incipient weed species, of which about 16 are present and believed to be serious threats in management units (U.S. Army Garrison 2005b). Twelve species are identified for total eradication within the management units: the grasses *Ehrharta stipioides* and *Pennisetum setaceum*; the herbaceous shrub *Achyranthes aspera*; herbaceous thistle *Cisium vulgare*; and herbaceous climber *Desmodium intortum*; the shrubs *Rubus argutus* and *Triumfetta semitriloba*; and the trees *Acacia mearnsii, Araucaria columnaris, Casuarina glauca, Syzgium jambos,* and *Tecoma capensis* (U.S. Army Garrison 2006d). In particular, a large occurrence of *Casuarina glauca* adjacent to the Kahanahaiki Management Unit poses a serious fire threat (U.S. Army Garrison 2005b). Other weed control efforts in the action area focus on "weed control areas" in the eight management units, located entirely or partially within the action area (see Stabilization under Project Description).

Non-native invertebrates are a particularly serious threat to certain listed plants and native associates within the action area because safe, effective control measures are unavailable for use in natural areas. To address this concern, the Army recently hired research and monitoring specialists to conduct management-related research and to coordinate with other researchers to develop control techniques for slugs and black twig borers (U.S. Army Garrison 2005b). A priority issue is development of slug baits that will not harm native tree snails and the development of black twig borer controls that will not harm native scolytid beetles. In addition, the Army is supporting doctoral research on Oahu tree snail predation and *Euglandina rosea* food habits and control methods.

Stabilization Exposure Area

Listed resources in the action area will be exposed to stabilization subsidies that include: (1) reduced exposure to stressors associated with the introduction and spread of non-native species by implementing phytosanitation measures, controlling existing sources of non-native plants on Makua, and reducing the abundance of non-native animals and invertebrates; (2) augmentation and reintroduction to increase baseline numbers of target plant taxa; (3) collection and storage of propagules for propagation and *ex situ* genetic storage; (4) captive propagation of *Achatinella mustelina*; and (5) comprehensive monitoring to assess the biological and compliance goals of the Makua Implementation Plan Addendum.

The area that will be exposed to stabilization subsidies includes all population units for target plant taxa and evolutionarily significant units of Oahu tree snails within the action area and management units where ecosystem-level threats will be controlled. As discussed in the Stabilization section of the Project Description, the Army's Makua Implementation Plan Addendum has modified the Makua Implementation Plan by reducing the number of population units that will be managed for stability and the number and area of management units. The Makua Implementation Plan had included about 188 plant population units for stabilization and approximately 2,571 ha (6,353 ac) of habitat to be actively managed within 31 management units. Under the reduced plan, about 92 plant population units will be stabilized and approximately 934 ha (2,307 ac) will be managed within 23 management units.

Makua Implementation Plan Addendum management units are designated in high quality habitat and designed to provide sufficient area for stabilizing *in situ* (naturally occurring) and reintroduced population units of target plant taxa. The larger management units (e.g., Ohikilolo within the action area and Pahole partially within the action area, and East Makaleha and Ekahanui outside the action area) encompass relatively high densities of many species that are being managed for stability, large areas of relatively intact native-dominated vegetation, and locations accessible to management. Many management units occur at elevations below 762 m (2,500 ft), where most native ecosystem loss has occurred, and will need habitat restoration in selected areas. Some of the management units are surrounded by lands not included in the stabilization program; other management units are adjacent to each other (although separated by boundary fences). Adjacent management units that are entirely or partially within the action area (e.g., Lower Ohikilolo and Ohikilolo; and Kahanahaiki, Pahole, Upper Kapuna, and West Makaleha) provide large contiguous landscapes of habitat for endangered and other native species. Each management unit, however, is managed independently.

Some areas on Makua that contain plant population units, management units, and Oahu elepaio critical habitat are closed to access by Army Natural Resources Staff because of the presence of unexploded ordnance. Listed resources in these areas will not be exposed to the full subsidies of on-site stabilization (e.g., intensive weeding, augmentation, seed collection, and monitoring). The Army also has not had consistent access for weed control and other stabilization activities on State lands in the Pahole, Upper Kapuna, and West Makaleha management units (U.S. Army Garrison 2005b, 2006d). According to Army Natural Resources Staff, restricted access to State lands has resulted in increased grass cover in previously weeded areas.

Stabilization Timing, Duration, and Frequency

The Army has been implementing stabilization actions under the Makua Implementation Plan since 2003, and under the Makua Implementation Plan Addendum since early 2005. In addition, certain "urgent actions" were implemented from 1999 to 2004, while the Makua Implementation Plan was being developed. Stabilization actions are conducted on an ongoing basis throughout the year, depending on the appropriate season for seed collection, greenhouse operations, and outplanting for 27 of the 28 target plant taxa (*Gouania vitifolia* is a new species to be added to the Makua stabilization plan as a result of this consultation). The frequency of certain actions, including monitoring, varies according to species-specific needs that are outlined in the Makua Implementation Plan Addendum and Makua Implementation Plan. The duration of stabilization subsidies is expected to last as long as the Army trains at Makua and implements the actions outlined in the Makua Implementation Plan Addendum. If the Army discontinues conservation management at Makua or on non-Army lands within the action area, the benefits of stabilization will not be perpetuated. Native species and habitats in Hawaii require active, ongoing management to persist under the constant threat of competition with and displacement by non-native invasive species.

The Makua Implementation Plan was originally designed to be implemented in three phases to achieve stabilization of the original 27 target taxa over 33 years. That planning horizon was considered "speculative," given the lack of information available on the target species and the adaptive management adjustments that were expected over time. Phase A (years 1 to 13) include landowner negotiations, National Environmental Policy Act and other legal responsibilities, genetic storage, and initiation of essential research. Phase B (years 14 to 23) and Phase C (years 24 to 33) include developing and implementing fire management and threat control plans, seed collection, population and habitat monitoring, and population unit management. Specific biological criteria to evaluate the success of management for each taxon, such as minimum viable population size, could not be predicted due to lack of demographic and genetic data. Therefore, the Service originally intended to assess success in the short term by verifying the Army's implementation of management actions according to the schedule stipulated in the Makua Implementation Plan.

The Army has budgeted the Makua Implementation Plan Addendum's planning horizon for 20 years, although the time needed to achieve stabilization of 28 target plant taxa cannot be predicted. No anticipated timeline for success is included in the Makua Implementation Plan Addendum, nor contingency plans for stabilizing population units outside Makua, if State, city/county, or private lands are unavailable. The Makua Implementation Team (2003) recognized that delaying certain actions will adversely affect some population units and perhaps significantly reduce the likelihood of successful stabilization. Because of uncertainty regarding the timely achievement of stabilization goals, the Service is unable to determine that any species will be stabilized over the next 30 years or within any specified timeframe. For this reason, certain Addendum actions for the most at-risk plant taxa will be implemented on an accelerated schedule, and will be completed before tracers and certain other long-range weaponry are used (see General Effects of Expedited Stabilization below). Meanwhile, Makua Implementation Plan Addendum stabilization actions will continue to be implemented over the long-term for all target taxa.

Stabilization Intensity

The intensity of exposure of listed resources to stabilization subsidies depends on species-specific needs for protection against non-native invasive species, and on the need for outplanting to augment and reintroduce individuals and occurrences. For example, five of the eight management units within or partially within the action area are fenced or partially fenced, and fence construction for the others is planned over the next one to seven years

(Upper Kapuna will be partially fenced). Some plant taxa also require small individual strategic fences around particular population units; other population units do not require any fence protection because they are located on cliff faces or other areas inaccessible to feral ungulates. In addition, the amount of ungulate removal, weeding, rat control, and slug and insect control needed in population units and management units is location and species-specific and changes over time. In general, the Makua Implementation Plan Addendum and Makua Implementation Plan provide for the intensity of protection and population augmentation efforts needed to stabilize the target taxa, as determined by the Makua Implementation Team (2003).

Physical, Chemical, and Biotic Features Exposed to Stabilization

Within stabilization exposure areas (i.e., population units and management units), physical, biotic, and chemical features essential to listed species and critical habitats will be directly and indirectly exposed to Makua Implementation Plan Addendum subsidies. Physical features include mineral soil seed beds and microclimate conditions. Chemical features include soil nutrient/moisture levels and availability. Biotic features include all life forms within population units and management units, including listed plants, tree snails, and birds; associated native plants and animals; tree snail host trees; and nesting and foraging habitat for Oahu elepaio.

Listed Resources Exposed to Stabilization

Within the action area, 28 target plant taxa and the Oahu tree snail *Achatinella mustelina* are designated for stabilization management. Stabilization actions implemented for these target also will benefit individuals and occurrences of 11 non-target plant taxa where they occur in the management units, and improve the conservation value of critical habitat areas for 36 plant taxa and for the Oahu elepaio that overlap the management units. The Makua Implementation Plan (Makua Implementation Team 2003) and the Army’s Makua Implementation Plan Addendum (U.S. Army Garrison 2005a) outline stabilization protocols for 27 plant target taxa and *A. mustelina*. Both documents are based on the action area considered in the Service’s previous opinions (Service 1999b, 2001b, 2004a). Because of new information provided primarily by fire model simulations, the new action area for this opinion encompasses all of the existing individuals for an additional plant species, *Gouania vitifolia*, which will be added to the Makua Implementation Plan Addendum’s stabilization plan (see Status and Environmental Baseline descriptions for *G. vitifolia*).

Response of Listed Resources Exposed to Stabilization

Target taxa will respond to stabilization subsidies affecting the physical, chemical, and biotic factors identified above. More germination sites will become available to native plants as soil erosion and compaction damage by feral ungulates is reduced and invasive weeds are removed and controlled. Soil nutrient/moisture levels and availability will change with the relative composition of native and non-native plants, and more of these resources will become available to enhance the growth and vigor of native plants. Allelopathic chemicals that inhibit the germination and growth of native plants will diminish as non-native species such as Christmas berry and strawberry guava are removed and controlled. With canopy management, microclimate conditions will develop that discourage invasive weeds; growth of canopy trees will enhance shade and mesic conditions while open conditions that favor grasses will decrease. For example, in some areas the Army has outplanted the native trees *Acacia koa* and *Myrsine lessertiana* to increase overstory canopy for control of shade-intolerant alien weeds. Over time, the conversion of native habitats to grassland will slow and ecosystem vulnerability to fire will be reduced. In the Lower Ohikilolo Management Unit, control of guinea grass and *Leucaena leucocephala* (koa haole) shrubs in fuelbreaks over the last five years has reduced the incidence of fires that threaten endangered plants. Without competition from non-native grasses and shrubs, these alien-dominated sites developed into mixed native shublands containing alien broadleaf weeds and native shrubs (*Dodonaea viscosa*, *Sida fallax*, *Waltheria indica*, and *Abutilon incanum*) (U.S. Army Garrison 2005b).

Over time, habitat management, including invasive species control and outplanting of native species, will alter species composition, increase the relative abundance and distribution of native plant species, and influence long-term patterns of vegetation development and succession. The overall response of listed resources to stabilization subsidies will be a measurable increase in numbers of individuals and occurrences of target plant taxa and native plant associates that provide primary constituent elements of plant critical habitat. Listed and other native plants will respond with increased vigor, survival, and reproduction due to reduced habitat degradation by feral ungulates; reduced competition, predation, and herbivory by alien plants, animals, and invertebrates; and increased augmentation and reintroduction of outplanted individuals. The overall response will be increased baseline numbers of individuals of target plant taxa that will improve population viability and reduce the risk of species extinction. Native plant associates, as primary constituent elements of critical habitat, will increase in quantity, quality, and availability, thereby increasing the conservation value of critical habitat for listed species.

The Service has determined that any short-term adverse impacts over the next 30 years associated with stabilization actions will be insignificant or discountable, and will not result in take of Oahu tree snails or Oahu elepaio, or loss of listed plants below existing baselines. Certain management actions, however, may expose listed resources to short-term, insignificant impacts associated with (1) the disturbance of human presence, (2) inadequate control of non-native species, (3) low survival of outplants and over-collection of propagules, and (4) lack of adequate population monitoring data. These minor impacts are discussed below.

(1) Ground disturbance associated with human activity may temporarily disturb Oahu elepaio during monitoring surveys, fence construction and maintenance, ungulate removal (snaring, hunting, aerial shooting), rat baiting/trapping, and outplanting. People also may inadvertently trample native vegetation, spread invasive plant seeds, and dislodge tree snails. These impacts will be minimized by limiting implementation of stabilization actions to trained biologists and technicians.

(2) Inadequate control of non-native species may limit or delay stabilization of certain taxa. Owing to personnel and funding constraints, Army Natural Resources Staff has been unable to fully implement the level of weed control outlined in the Makua Implementation Plan (U.S. Army Garrison 2006d). For example, the goal for incipient weed control is total eradication, but some weed species have increased to levels where eradication is no longer feasible. Moreover, once a species is considered established, it no longer receives special attention for total eradication and is treated only during general weed sweeps in high priority areas. In addition, intensive weed control is conducted only in fenced management units or in unfenced areas where ungulates are not a threat because of steep topography. In some sites at Makua, removal of alien grasses has increased the spread of other herbaceous weeds such as *Leonotis nepetifolia* and *Ageratum conyzoides*. These impacts will be minimized by careful, regular weeding to maintain appropriate microclimate and light/shade regimes and to prevent the replacement of certain alien weeds with others. For example, canopy strawberry guava trees are sometimes left in place because removal would create light gaps that facilitate alien grass invasion in the understory. Canopy shade is also increased in some areas to inhibit weed growth by outplanting native trees in large light gaps.

Weed control techniques also may result in inadvertent damage to listed species and other native plants. Alien weeds are controlled in various action area locations by mowing, weed-whacking, herbicide application, and hand-pulling. Damage to native vegetation associated with these activities will be minimized by limiting implementation of stabilization actions to trained biologists and technicians. Army Natural Resources Staff includes expert botanists who recognize native species and take precautions to avoid harming them. For example, in all herbicide treatment areas, rare native species are flagged before alien vegetation is sprayed. Molasses grass is usually controlled by herbicide spray applications, but is hand-pulled in areas near the native endangered grass *Cenchrus agrimonioides* var. *agrimonioides*. In addition, to control guinea grass, the Army uses herbicides that do not affect native broadleaf species, such as “Round-up Pro” and “Fusilade II.” “Fusilade II” is a grass-specific herbicide that has been successful in maintaining forest understories grass-free (U.S. Army Garrison 2005b). All herbicides are applied according to the label registration.

The current design of snail exclosures may be inadequate to thoroughly protect occurrences of *Achatinella mustelina* from predation by the non-native carnivorous snail *Euglandina rosea*. The two snail exclosures in the Kahanahaiki and Pahole management units consist of sheet-metal fences with salt troughs and electrical barriers. This exclosure design is not impenetrable to rats but appears to be excluding *E. rosea*. However, *A. mustelina* have occasionally been found in the salt troughs, *E. rosea* have been found inside the Pahole exclosure, and the electrical barriers often do not function properly. In addition, overstory clearing along the exclosure’s perimeter to reduce rat access has created a drier environment within the exclosures. These impacts will be minimized by enhanced maintenance of the exclosures and investigation of design modifications to these exclosures and to any new exclosures that may be constructed (U.S. Army Garrison 2005b, 2006d).

Control methods for insect pests (especially the black twig borer and Chinese rose beetle) are currently not available for use in forests and natural areas. Systemic insecticides applied to individual plants to control alien insects may also injure or kill native insects. Similarly, chemicals to control slugs may also harm native tree snails. Certain *Schiedea* species, for example, are unlikely to be stabilized without adequate slug control. This lack of field control methods will be minimized by Army-supported research to determine the effects of pesticides on native invertebrates so that control methods can benefit stabilization of target plant taxa.

(3) Low survival of outplants and over-collection of propagules may limit the success of augmentation and reintroduction of certain target taxa, particularly those vulnerable to damage by non-native slugs and insects. Until invertebrate threats and other limiting environmental factors can be controlled, constant replenishment by outplanting may be needed to achieve and maintain stable plant numbers. As a result, *in situ* seed sources and *ex situ* storage supplies may be depleted. Other constraints on outplanting include low seed productivity in certain taxa, inaccessibility of some naturally occurring seed sources, and inadequate greenhouse capacity for propagation and pre-outplant conditioning. These impacts will be minimized by careful monitoring of outplant survival, maintenance of genetic seed storage goals, identification of site limiting factors (e.g., shade, water, nutrients), and research on slug and insect control methods.

(4) Lack of adequate long-term population monitoring data may limit or delay stabilization of certain taxa as a result of inadequate knowledge of population dynamics. For example, *Sanicula mariversa* undergoes a complex dormancy cycle that is not well understood. This impact will be minimized by the Army's development of a comprehensive monitoring program to assess completion of the Makua Implementation Plan Addendum's biological and compliance goals, the Army's recent hiring of a manager to oversee the monitoring program, and annual review of all stabilization activities by the interagency Makua Implementation Team. Priority monitoring issues for 2007, for example, include demography studies of *S. mariversa*, *Chamaesyce celastroides* var. *kaenana*, and survivorship analysis of *Phyllostegia kaalaensis* (U.S. Army Garrison 2006d).

Expedited Stabilization of At-Risk Plant Taxa

The Army's proposed action incorporates an expedited stabilization plan over the next 30 years for 12 of the stabilization target taxa identified as most at-risk from exposure to project stressors. The expedited stabilization plan for these taxa modifies certain priorities in the species-specific conservation actions outlined in the Makua Implementation Plan Addendum and Makua Implementation Plan, and accelerates their implementation. Until the 12 at-risk taxa have attained expedited, modified stabilization goals, the Army will not use any weapons systems and munitions that were not covered in the Service's 2001 Supplement and 2004 Critical Habitat Reinitiation (i.e., tracers, 155 mm HE artillery, TOW missiles, Javelin anti-tank missiles, and 2.75-caliber helicopter-launched rockets). In addition, other weapons systems and munitions will be used only according to NFDRS and live fuel moisture conditions outlined in this opinion (see Table PD 2).

The Makua Implementation Team (2003) recognized that the phased approach of the Makua Implementation Plan would delay certain actions, which could significantly reduce the likelihood of successful stabilization for certain seriously endangered plant taxa in the action area. Therefore, certain taxa at greatest risk from training impacts (i.e., those with very low numbers and located within a high fire risk zone) were intended to receive all needed management during Phase A (years 1 to 13) of the Makua Implementation Plan's 33-year schedule. These taxa included *Hibiscus brackenridgei* ssp. *mokuleianus*, *Chamaesyce celastroides* var. *kaenana*, *Melanthera tenuifolia*, *Nototrichium humile*, and *Tetramolopium filiforme*. One of these, *Hibiscus brackenridgei* ssp. *mokuleianus*, has now been designated as an "at-risk" species scheduled for expedited stabilization over the next 30 years. *Chamaesyce celastroides* var. *kaenana*, *Nototrichium humile*, and *Tetramolopium filiforme* remain as target taxa for stabilization, but are not designated for expedited stabilization due to their relatively high numbers and the existence of at least two numerically stable population units for each taxon. *Melanthera tenuifolia* also remains a target taxon for stabilization, but it is not designated for expedited stabilization due to its relatively high numbers.

Twelve target taxa have been designated as "at-risk" taxa scheduled for expedited stabilization over the next 30 years, based on the criteria discussed in the "Expedited Stabilization" section of this opinion's Project Description. The Service reasonably expects that achievement of expedited stabilization will protect these at-risk taxa from jeopardy over the next 30 years, while long-term stabilization actions are being implemented for all stabilization species. The Service expects the Army will fully fund Makua Implementation Plan Addendum actions, including expedited stabilization.

In general, expedited stabilization measures are based on continuing management of all *in situ* population units for all 28 plant target taxa, which the Army is currently implementing under the Makua Implementation Plan Addendum. In addition, for each of the 12 at-risk taxa, the Army will expedite priorities to attain modified stabilization goals for all action area population units, and of one to three population units outside the action area, as identified in the Addendum. The major purpose of expedited stabilization is accelerated improvement of population units outside the action area, where they will not be exposed to training-related wildfire. In some cases, establishment of reintroductions on State, city/county, or private lands will be accelerated. For all stabilization population units (three or four per taxon), the Army will ensure that adequate numbers of individuals, including both mature and immature, are outplanted and maintained to conform to the modified numerical stabilization criteria. Expedited stabilization involves prioritizing the implementation of conservation actions for the 12 at-risk taxa, according to the protocols and population units identified in the Makua Implementation Plan Addendum and the Makua Implementation Plan; the basic premises and details of those plans have not been changed. The Army estimates that expedited, modified stabilization can be achieved, with adequate funding, within three to seven years for most of the at-risk taxa. One species with periodic dormancy, *Sanicula mariversa*, may require a longer timeline because preliminary monitoring must be conducted and evaluated to determine appropriate population goals and techniques for stabilization.

Expedited stabilization likely will not result in full stabilization of the 12 at-risk taxa over the next 30 years. Full stabilization requires at least three stable population units per taxon, each consisting of specific numerical goals for mature, reproducing individuals; complete control of threats; and complete *ex situ* genetic storage. Expedited stabilization will result in at least three population units consisting of goal criteria for total individuals (both mature and immature), with threats controlled to the extent that threshold numbers are maintained from year to year. Genetic storage goals may or may not be completed over the next 30 years. Nonetheless, expedited stabilization will significantly increase numbers and distributions of the at-risk taxa. In particular, each will be protected from jeopardy by achieving expedited numerical stabilization goals in at least one population unit, or in most cases at least two population units, outside the action area. To achieve expedited stabilization goals, fence construction schedules will be accelerated for the Makaha, West Makaleha, and Upper Kapuna management units. These management units are needed as stabilization population units for six, four, and six at-risk taxa each, respectively. Besides these, other management units also will be fenced to achieve expedited stabilization for eight at-risk taxa.

The general effects analysis for expedited stabilization is the same as that described above for full stabilization. For expedited stabilization, however, the exposure area and the individuals affected will be limited to population units to be managed for stability for the designated 12 at-risk taxa. Stabilization population units, which also apply to expedited stabilization of the at-risk taxa, are discussed in the species-specific status, environmental baseline, and effects analysis sections of this opinion. In addition to expedited stabilization, certain weapons restrictions and fire protection actions outlined in Table PD 2 are expected to protect the 12 at-risk taxa from jeopardy while full stabilization is being implemented for all 28 plant target taxa over the next 30 years.

The expedited stabilization actions are intended to control threats and increase the baselines in overall numbers and distribution of the 12 at-risk taxa as rapidly as possible. Increased individual fitness and viability of population units, especially of those outside the action area, are considered critical to protect these taxa from jeopardy over the next 30 years. Successful achievement of expedited, modified stabilization for these taxa will not occur without full Army funding of the Makua Implementation Plan Addendum and the Wildland Fire Management Plan. The Service reasonably expects the 12 at-risk taxa will be protected from jeopardy over the next 30 years because the Army will not be able to use certain weapons systems and munitions until those taxa have attained expedited stabilization thresholds. Lack of adequate seed sources for propagation and outplanting, and for genetic storage, may limit or delay augmentation and reintroduction of some taxa. The Army and Service will closely monitor expedited stabilization actions each year to assure adequate survival of outplantings and prevent depletion of seed sources for genetic storage, and to determine the Army's progress toward achieving expedited stabilization of the 12 at-risk taxa. The annual review will also allow for modification of stabilization actions as needed, using an adaptive management approach.

Summary of General Effects Analysis

The proposed action will adversely affect endangered plant and animal species in the action area by exposing them to stressors associated with training-related wildfire, introduction and spread of non-native species, and the physical disturbance of human activity. Fire ignited by live-fire training is the most significant threat to listed species and critical habitat in the action area. In general, the Service anticipates that individuals and occurrences of listed species, and primary constituent elements of critical habitat, will be exposed to training-related wildfire of high, low and very low severity within the action area. Individuals, occurrences, or entire population units of listed plants in the action area are at various (high, low, or very low) risks of burning over the next 30 years. Fire also will destroy other native plant associates, degrade habitat quality for listed individuals that remain, and inhibit natural regeneration by creating conditions more favorable for faster-growing alien grasses. Enhanced regeneration of non-native grasses will predispose burned areas to future fires and increase the risk of fire ignition and spread to other native habitats. Fire and alien plant invasion in critical habitat areas also will adversely affect native plants that comprise the primary constituent elements determined to be essential for the survival and recovery of listed plants and the Oahu elepaio. Thus, the proposed action's risk of training-related wildfire is likely to reduce baseline numbers of listed species in the action area and reduce the quality, quantity, and availability of primary constituent elements of critical habitat.

To minimize the impacts of training-related wildfire at Makua, the proposed action includes several conservation and stewardship programs to prevent and suppress fire. The Army is implementing a Wildland Fire Management Plan that incorporates the NFDRS and live fuel moisture conditions into standard operating procedures for weapons training. The NFDRS limits on live-fire training will preclude use of high-risk, fire-igniting weapons systems and munitions during adverse weather conditions, such as during the dry summer months. The Army also proposes to significantly increase helicopter support and fire-bucket productivity for firefighting response. The Makua Integrated Natural Resource Management Plan includes components for weed control in training areas to reduce fuel loads. In addition, the Army is proposing additional firebreaks and fuel modification improvements to protect population units of endangered plants as part of the proposed action.

The Army also is implementing endangered species stabilization actions under the proposed Makua Implementation Plan Addendum and the Makua Implementation Plan, which over the long term will increase baseline numbers of 28 plant target taxa and the Oahu tree snail, *Achatinella mustelina*. Stabilization actions will include population unit management of target plant taxa, including augmentation and reintroduction of individual plants as needed; and ecosystem-level habitat improvement in management units, including control of non-native feral ungulates, invasive plants, and invertebrate pests. Twelve of the most at-risk target plant taxa will be managed for expedited stabilization over the next 30 years. Expedited stabilization is expected to result in at least three population units at numerical goals for stability for each taxon, including one or two population units outside the action area where they will not be exposed to training-related wildfire. Furthermore, the Army will not train with certain high-risk, fire-igniting weapons systems and munitions until expedited stabilization of the 12 at-risk taxa is achieved. Finally, any areas of critical habitat destroyed or degraded by fire will be revegetated. The overall response of listed resources to the proposed action's stressors and subsidies will depend on the frequency, intensity, location, and extent of training-related wildfire, the success of the Wildland Fire Management Plan and Integrated Natural Resource Management Plan programs in reducing fire ignition and spread, and the timely success of stabilization under the Makua Implementation Plan Addendum (including expedited stabilization of 12 at-risk plant taxa) over the next 30 years.

EFFECTS OF THE ACTION ON STABILIZATION TAXA

The 16 target taxa listed below have been identified for stabilization, based primarily on their overall status, environmental baseline within the action area, and exposure to the risk of training-related wildland fire (see Table E 7). A taxon was designated for stabilization if certain numerical criteria were not met and if at least 50 percent of all its individuals were located within the action area. Location within the action area by definition means these individuals are at risk of training-related wildland fire. Taxon-specific information supporting this group effects analysis for the 16 stabilization taxa are included in the Status and Baseline Section.

Alectryon macrococcus var. *macrococcus* (tree)
Cenchrus agrimonioides var. *agrimonioides* (grass)
Chamaesyce celastroides var. *kaenana* (shrub, small tree)
Cyrtandra dentata (shrub)
Dubautia herbstobatae (subshrub)
Flueggea neowawraea (tree)
Hedyotis degeneri var. *degeneri* (shrub)
Hedyotis parvula (shrub)
Hesperomannia arbuscula (shrub, small tree)
Melanthera tenuifolia (perennial herb)
Nototrichium humile (shrub, small tree)
Plantago princeps var. *princeps* (subshrub, shrub)
Pritchardia kaalae (palm)
Schiedea kaalae (shrub)
Tetramolopium filiforme (shrub)
Viola chamissoniana ssp. *chamissoniana* (subshrub)

<u>Status Summary of Stabilization Taxa</u>

Data on abundance, distribution, and reproduction of the 16 stabilization taxa are generally inadequate to predict quantifiable changes in their baseline conditions over the next 30 years, with or without the proposed action. Most are limited to population units on Oahu and are endemic to that island. Three stabilization taxa also occur on other islands: *Alectryon macrococcus* var. *macrococcus* (12 percent of total population on Oahu), *Cenchrus agrimonioides* var. *agrimonioides* (52 percent on Oahu), and *Flueggea neowawraea* (49 percent on Oahu). The current abundance of these 16 stabilization taxa on Oahu ranges from 22 total individuals for *Hesperomannia arbuscula* to 3,500 total individuals for *Tetramolopium filiforme*. Ten of the 16 stabilization taxa have not met minimum threshold of individuals to reach stabilization criteria in all population units (based on number of mature individuals, successful reproduction may not be occurring in all cases) inside and outside the action area: *Cyrtandra dentata*, *Dubautia herbstobatae*, *Flueggea neowawraea*, *Hedyotis degeneri* var. *degeneri*, *Hesperomannia arbuscula*, *Plantago princeps* var. *princeps*, *Pritchardia kaalae*, *Schiedea kaalae*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*. Of these, four taxa have not met minimum threshold of individuals to reach stabilization criteria in any of the stabilization population units: *Flueggea neowawraea*, *Hesperomannia arbuscula*, *Plantago princeps* var. *princeps*, and *Schiedea kaalae*; however, these four taxa were not identified as at-risk taxa for expedited stabilization. *Flueggea neowawraea* occurs in scattered locations on

Table E 7. Status of Stabilization Taxa (U.S. Army Garrison 2006d).

Taxon	Total Number of Individuals (mature/immatur)	Percent of Total Individuals in the Action Area	Number of Stabilization Population Units Exceeding Minimum Number of Individuals (existing‡/required)	Number of Stabilization Population Units Exceeding Minimum Number of Individuals Outside Action Area (existing‡/required)	Population Units with Fences (existing/required)	Fire Risk†
Alectryon macrococcus var. *macrococcus*	223 (198/25)*	30*	2/4	2/2	0/4	L, V
Cenchrus agrimonioides var. *agrimonioides*	529 (432/97)	57*	2/3	1/2	1/3	L, V
Chamaesyce celastroides var. *kaenana*	951 (844/107)	54	4/4	3/3	4/4	H
Cyrtandra dentate	1583 (721/862)	92	2/3	0/1	1/3	L
Dubautia herbstobatae	1217 (1206/11)	98	2/3	0/1	3/3	L, V
Flueggea neowawraea	128 (39/89)*	57*	0/3	0/2	0/3	L, V
Hedyotis degeneri var. *degeneri*	613 (569/44)	86	1/3	0/2	1/3	L
Hedyotis parvula	322 (207/115)	58	2/3	1/2	2/3	V
Hesperomannia arbuscula	22 (11/11=22)	4	0/3	0/2	1/3	V
Melanthera tenuifolia	3254 (2585/669)	50	3/3	2/2	2/3	H, L,V
Nototrichium humile	1256 (1087/153)	68	4/4	2/2	2/4	H, L, V
Plantago princeps var. *princes*	354 (126/228)	12	0/4	0/3	1/4	V
Pritchardia kaalae	911 (137/774)	92	2/3	1/1	2/3	L, V
Schiedea kaalae	235 (185/50)	9	0/4	0/3	4/4	V
Tetramolopium filiforme	3500 (2875/625)	96	1/4	0/2	3/4	H, L, V
Viola chamissoniana ssp. *chamissoniana*	662 (637/25)	81	1/4	0/2	3/4	V

*Totals for the Island of Oahu
‡ Individuals may not be reproducing successfully due to threats which have not yet been abated.
†Fire Risk: H (high), L (low), V (very low)

Oahu, Kauai, Maui, and Hawaii; *Hesperomannia arbuscula* and *Schiedea kaalae* each have only one plant (or five percent and less than one percent, respectively, of their total range-wide populations) located in the action area; and *Plantago princeps* var. *princeps* is relatively abundant at 354 total individuals.

Three taxa meet or exceed the minimum number mature individuals for stabilization populations in all their required stabilization population units: *Chamaesyce celastroides* var. *kaenana*, *Melanthera tenuifolia*, and *Nototrichium humile*. Five taxa are approaching the required number of mature individuals for stabilization population units (two out of a required three or three out of a required four), *Cenchrus agrimonioides* var. *agrimonioides*, *Cyrtandra dentata*, *Dubautia herbstobatae*, *Hedyotis parvula*, and *Pritchardia kaalae*. However, these taxa are not considered stabilized because they are not self-sustaining (*Cenchrus agrimonioides* var. *agrimonioides* and *Pritchardia kaalae* population units rely on augmentation with outplanted seedlings), threats are not controlled (e.g., fire, feral ungulates, rats, invasive plants), and *ex situ* genetic storage is not complete.

Eight of the 16 stabilization taxa (*Chamaesyce celastroides* var. *kaenana*, *Cyrtandra dentata*, *Dubautia herbstobatae*, *Hedyotis degeneri* var. *degeneri*, *Hedyotis parvula*, *Melanthera tenuifolia, Nototrichium humile*, and *Viola chamissoniana* ssp. *chamissoniana*) have the capacity to recruit in the wild when threats are managed (ungulate fencing, weed control, herbivore control). These eight taxa generally produce adequate juveniles and seedlings or reproduce vegetatively to a degree that will sustain population units and will not require reintroduction to achieve stabilization (U.S. Army Garrison 2006d). Two other taxa, *Cenchrus agrimonioides* var. *agrimonioides* and *Tetramolopium filiforme*, are also thought to have the capacity to regenerate naturally but will require reintroduction to establish stabilization numeric targets and/or population unit criteria (U.S. Army Garrison 2006d). Four stabilization taxa (*Hesperomannia arbuscula*, *Pritchardia kaalae*, *Plantago princeps* var. *princeps,* and *Schiedea kaalae*) produce seedlings in the wild or at reintroduction sites; however, they may still have uncontrolled threats (slugs or black twig borers), and thus will require reintroduction or augmentation to achieve stabilization. Two stabilization taxa, *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea,* have never produced seedlings in the wild or at reintroduction sites and will require reintroductions or augmentations, probably through additional research on regeneration techniques as well as black twig borer control.

The population trends of most of the stabilization taxa appear to be increasing more or less sustaining their numbers since initiation of the Makua Implementation Plan in 2003. Some of them have increased only slightly; some have increased the number of immature, but not mature, individuals; and some have increased owing in large part to new discoveries of additional plants. The population trends of two taxa, *Hesperomania arbuscula* and *Plantago princeps* var. *princeps,* seem to be decreasing in numbers even with stabilization management, and *Hedyotis degeneri* var. *degeneri* seems to be increasing in the action area and decreasing elsewhere. Because of inadequate numbers of mature, reproducing individuals in some population units and lack of at least three population units at numerical stabilization goals, all 16 stabilization taxa are considered to have a high background risk of extinction both in the action area and range-wide. Thus, stabilization management over the long term is necessary to protect these taxa from jeopardy due to the adverse impacts of military training.

Analyses for Effects of the Action

Individuals of the 16 stabilization taxa in the action area will be exposed to training-related wildland fire and the ongoing impacts of non-native species. Effects of human disturbance (trampling) are considered minor. The life forms of these stabilization taxa include a grass, a perennial herbaceous plant, partially woody subshrubs, woody shrubs and small trees, a palm, and dominant or subdominant forest trees.

Individuals of these 16 taxa will be exposed to the direct and indirect effects of training-related wildland fire over the next 30 years, due to their occurrence within the action area in zones at high, low, or very low risk of training-related wildland fire (Table E 8). All individuals and life stages are vulnerable to high and very low severity fires throughout the year, depending on phenology and the time of year fire occurs. Stabilization taxa with some or many individuals located in areas at high risk of fire include *Chamaesyce celastroides* var. *kaenana*, *Melanthera tenuifolia*, *Nototrichium humile*, and *Tetramolopium filiforme*. These plants are likely to be burned under certain conditions. Even full staffing of on-site and standby fire suppression helicopter forces will not guarantee containment of all fires. On approximately 1.5 percent of historical potential training days analyzed, on-site and standby helicopter containment would have failed to contain a fire burning outside the firebreak road, if the fire had not been successfully contained before 1 p.m. If additional contingency fire suppression resources are not called, these fires would escape initial attack and burn large acreages. Large fires and fires escaping initial attack are likely to burn into the native forest (see General Effects—Fire Suppression Table E 3). In addition, without the fuel treatments proposed, *Chamaesyce celastroides* var. *kaenana* plants (as well as the at-risk taxon *Hibiscus brackenridgei* ssp. *mokuleianus*) in the Lower Ohikilolo Management Unit are particularly vulnerable to training-related wildland fire because they are located within dry, grassy areas that have burned in the past.

Plants growing outside the high fire risk zone (i.e., within the low and very low fire risk zones) are at some risk of burning as a result of training-related wildland fire ignited by a misfired or malfunctioning long-range weapons systems and munitions (tracers, AT-4 and SMAW anti-tank weapons, 2.75-caliber rockets, Javelin anti-tank missiles, and TOW missiles). These plants also have a relatively low potential to burn from spot fires of various sizes, depending on topography, vegetation cover, weather, and suppression capability. The expected fire size resulting from a misfired long-range weapon or spot fire landing within intact shrub and/or forest vegetation is about 0.1 ha (0.3 ac) with immediate fire suppression response. However, if the fire is not noticed for 48 hours, it could spread to 40.5 ha (100 ac) before containment. In addition, plants within the low fire risk zone, especially those near the high fire risk zone could burn if a fire within the high fire risk zone creeps into the edge of the low risk zone. Only a small area is expected to burn because the fire will slow down when it hits the forest/shrub habitat.

The areas exposed to the effects of training-related wildland fire and invasive species in the action area include mixed native and non-native vegetation in mesic forest, dry forest, and dry grassland/shrubland habitats. Many population units of several taxa are at high risk of training-related wildland fire within dry, grassy habitats of the Kaluakauila, Lower Ohikilolo, and Kahanahaiki (C-Ridge vicinity) Management Units (*Cyrtandra dentata*, *Flueggea neowawraea*, *Hedyotis degeneri* var. *degeneri*, *Melanthera tenuifolia*, *Nototrichium humile*, and *Tetramolopium filiforme*). Population units within mesic, forested habitats in the Kahanahaiki,

Table E 8. Fire Risk for Stabilization Taxa.

Taxon	Individuals Occurring In Fire Risk Zones		
	High	**Low**	**Very Low**
Alectryon macrococcus var. *macrococcus*	0	22 (9) †*	61 (25)*
Cenchrus agrimonioides var. *agrimonioides*	0	194 (28)*	207 (29)*
Chamaesyce celastroides var. *kaenana*	511 (54)	0	0
Cyrtandra dentate	0	1396 (92)*	0
Dubautia herbstobatae	0	616 (52)*	550 (46)*
Flueggea neowawraea	0	64 (50)*	9 (7)*
Hedyotis degeneri var. *degeneri*	0	188 (53)	0
Hedyotis parvula	0	0	188 (44)
Hesperomannia arbuscula	0	0	1 (4)*
Melanthera tenuifolia	227 (7)	1,384 (42)	0
Nototrichium humile	590 (47)	267 (21)	1 (0)
Plantago princeps var. *princeps*	0	0	16 (5)
Pritchardia kaalae	0	769 (84)	72 (8)
Schiedea kaalae	0	0	22 (19)
Tetramolopium filiforme	1045 (30)	2085 (60)	200 (6)
Viola chamissoniana ssp. *chamissoniana*	0	0	500 (81)

†Number of individuals occurring in fire risk zone (percent of all individuals occurring in fire risk zone).
*Percent of individuals on the island of Oahu only

Pahole, Upper Kapuna, and West Makaleha Management Units are generally at lower risks of fire, except in areas of alien grass encroachment. Population units in the Ohikilolo Management Unit along the south valley rim and in the Keaau area beyond Ohikilolo Ridge are likewise at lesser risks of fire. Mesic conditions in upper slope forests do not preclude the incidence of fire, however, especially during prolonged drought conditions and in disturbed areas with grassy understories. The spread of wildland fire from the C-Ridge area into the Kahanahaiki Management Unit, for example, is strongly influenced by alien grass cover. Past fires, including the 1995 and 2003 escaped prescribed burns, increased the exposure of listed plants near this area to future fires by killing native vegetation and increasing flammable alien grass cover. Over half of the population units of the 16 stabilization taxa are located within fenced management units, but invasive weeds are not regularly controlled over all of them. Individuals under mesic forest canopy in weed control areas are probably fairly well protected from rapidly spreading intense fire. Other individuals in locations lacking weed control are not well protected from long-term fire encroachment into native and mixed forest.

To reduce the risk of training-related wildland fire to certain at-risk species, the Army will use certain types of weapons systems and munitions for training at Makua only after completion of specific measures to protect certain at-risk taxa (see General Effects of Expedited Stabilization and Table PD 2 in Project Description). Delaying the use of these weapons systems and munitions will also benefit stabilization species by reducing the long-range fire risk. In addition, to minimize threats to listed species, as part of the proposed action the Army will implement conservation and stewardship programs to reduce the risk of ignition and spread of training-related wildland fire and wildland fires occurring on State and private lands where these population units occur (Table E 9) (Wildland Fire Management Plan, Integrated Natural Resources Management Plan); reintroduce and augment numbers of stabilization taxa in the wild (Makua Implementation Plan Addendum); and improve native habitat in population units by excluding feral ungulates and controlling non-native weeds (Makua Implementation Addendum).

Table E 9. Stabilization Population Units Located on State, City/County, and Private Lands.

Taxon	State Lands	City/County Lands	Private Lands
Alectryon macrococcus var. *macrococcus*	Kahanahaiki to W. Makaleha*	Makaha	Central Kaluaa
Cenchrus agrimonioides var. *Agrimonioides*	Kahanahaiki & Pahole* Makaha & Waianae Kai		Central Ekahanui
Chamaesyce celastroides var. *kaenana*	Kaena (E. of Alau) Kaena & Keawaula Waianae Kai		
Cyrtandra dentate	Pahole to Upper Kapuna to W. Makaleha*		
Dubautia herbstobatae		Makaha	
Flueggea neowawraea	Kahanahaiki to Upper Kapuna* Central & East Makaleha	Makaha	
Hedyotis degeneri var. *degeneri*	Kahanahaiki to Pahole* Alaiheihe & Manuwai Central Makaleha & W. Branch of E. Makaleha		
Hedyotis parvula	E. Makaleha Halona		
Hesperomannia arbuscula	Upper Kapuna*	Makaha	N. Palawai
Melanthera tenuifolia	Kamaileunu & Waianae Kai Mt Kaala Natural Area Reserve		
Nototrichium humile	Waianae Kai		Kaimuhole & Palikea Gulch
Plantago princeps var. *princeps*			Ekahanui Konahuanui Waiawa
Pritchardia kaalae	Ohikilolo East & W. Makaleha* Makaleha to Manuwai		
Schiedea kaalae	Pahole*		Maakua S. Ekahanui Kaluaa & Waieli
Tetramolopium filiforme	Waianae Kai		
Viola chamissoniana ssp. *chamissoniana*	Halona	Makaha	

*Population units entirely or partially inside action area

The risk of fire to listed species will be minimized by training restrictions, fire management, and expedited stabilization actions. Fire minimization measures are based on required levels of helicopter staffing to contain fires. In addition, to reduce the fire risk to *Chamaesyce celastroides* var. *kaenana* plants (as well as to the at-risk taxon *Hibiscus brackenridgei* ssp. *mokuleianus*) in the Lower Ohikilolo Management Unit, the Army will not begin any live-fire or blank-fire training until alien grass cover is removed and controlled within 3 m (9.8 ft) of these plants and to less than 20 percent cover within the Lower Ohikilolo weed control areas. Additional fuel modification within a 60-m (197-ft) swath along the inside perimeter of the south firebreak road, as shown in Figure PD 6, will allow the Army to reduce the level of on-site helicopter staffing required for certain weapons. With these fuel modifications in place, the Army may train using small arms, demolitions, grenades, mines, simulators, and mortars and artillery, with the use of certain of these weapons systems and munitions restricted to NFDRS Green conditions. Within 5 to 10 years, plants growing within the Kahanahaiki and Kaluakauila management units will be protected by fuel modification and firebreaks; these protections will benefit the stabilization taxa noted above. With these management units better protected from fire and with completion of expedited stabilization of the at-risk taxa *Cyanea superba* ssp. s*uperba*, *Schiedea nuttalli*, and *Schiedea obovata*, the Army may begin training with more weapons systems and munitions under Yellow fire danger conditions instead of only under Green fire danger conditions and begin using grenade launchers and AT-4 and SMAW weapons under Green or Yellow fire danger conditions, depending on live herbaceous fuel moisture. Expedited stabilization of all 12 at-risk taxa must be complete before the Army may begin training with tracer ammunition, Javelins, and 2.75-caliber rockets. Thus, all listed species in the action area, including the 16 stabilization taxa, will benefit from training restrictions required until expedited stabilization is complete for all 12 at-risk species. Full stabilization of all 16 stabilization and all 12 at-risk taxa must be complete before the Army may begin training with TOWs.

Species Response to the Proposed Action

The response of individuals of the 16 stabilization taxa to training-related wildland fire and invasive species will include the direct and indirect effects of fire injury and death, ungulate grazing and trampling, invertebrate herbivory, and alien plant competition (see General Effects). As a result of these training-related impacts, the number of mature individuals and numerically stable population units of stabilization taxa in the action area are expected to decline over the next 30 years. The overall response to direct and indirect effects will be a measurable reduction in baseline numbers, distribution, and reproduction of individuals and/or entire occurrences in action area population units due to fire injury and death. Reduced individual fitness in plants that survive will further decrease the viability of population units through a continuing decline in baseline numbers. Without implementation of the Army’s conservation and stewardship programs, these effects would worsen the existing condition of stabilization taxa in the action area by constraining their resiliency (recovery rate from disturbance) and exacerbating their risk of extinction due to small population size. We infer from conservation biology principles and examples from other species that the 16 stabilization taxa have a high background risk of species extinction, and ongoing stabilization management is needed to protect them from existing and additional threats and to ensure their long-term persistence.

The Service anticipates that implementation of wildland fire suppression, fuels management, and species stabilization actions will prevent training-related declines in baseline numbers of individuals and population units of the 16 stabilization taxa. Over the next 30 years, Army stabilization management is expected to achieve important progress in attaining numerical stability criteria for the 16 stabilization taxa. Numbers of mature, reproducing individuals are expected to increase in at least three or four population units for each taxon, including at least one population unit outside the action area. The Army recently decided to identify four manage for stability population units for seven of the 16 stabilization taxa (U.S. Army Garrison 2006d). The criteria used to identify taxa that will be managed at four stabilization population units include: (1) presence in both the Makua and Schofield Barracks action areas (*Alectryon macrococcus* var. *macrococcus*, *Plantago princeps* var. *princeps*, *Schiedea kaalae*, *Tetramolopium filiforme, Viola chamissoniana* ssp. *chamissoniana*); and (2) presence in high fire threat areas in the Makua action area (*Chamaesyce celastroides* var. *kaenana, Nototrichium humile*). In addition, progress is expected over the next 30 years toward full threat control and full *ex situ* genetic storage for each taxon. Overall, the response of stabilization taxa to project subsidies is expected to result in measurable increases in individual fitness (survival, reproduction, and recruitment), increased baseline numbers of mature and immature individuals within population units, and expanded distribution of population units inside and outside the action area. Thus, Army conservation and stewardship programs will protect the 16 stabilization taxa from jeopardy over the next 30 years, improve their likelihood of reaching full stabilization over the long-term, and enhance their probability of persistence. Responses of certain stabilization taxa to project subsidies may involve indirect adverse effects.

Three of these taxa (*Cyrtandra dentata, Dubautia herbstobatae, Pritchardia kaalae*) will be managed for stability at only one population unit outside the action area. Army biologists believe that action area locations of these taxa represent their currently known and historical centers of abundance (K. Kawelo, U.S. Army Garrison, pers. comm. 2006). For this reason, the Army believes scarce propagule resources should not be used to augment or introduce population units outside their historically documented range. Thus, even when fully stabilized, these three taxa will have fewer individuals located outside the action area. However, the predicted fire risk to these taxa is low, and one population unit outside the action area likely will be adequate to achieve and maintain stability. The Army and the Service will closely monitor these taxa and revise management actions as necessary to ensure stabilization criteria are met.

The analysis in this section is based on information about the proposed action and the environmental baselines of the 16 stabilization taxa in the action area. In addition, we make general inferences from this set of circumstances according to conservation biology principles regarding small populations and from previous experience regarding threats to the conservation of native vegetation in Hawaii (see General Effects). We also make inferences from examples of other species that are closely related to some of the 16 stabilization taxa or have a similar life history, which have become unstable, endangered, or extinct. The genus *Schiedea*, for example, contains the highest proportion of endangered taxa of any species-rich lineage in the Hawaiian Islands, with 19 taxa (about 54 percent) listed as endangered and three designated as candidates for listing (see discussion under Effects of the Action on At-Risk Taxa). The declines of *S. kaalae*, and the at-risk taxa *S. nuttalllii* and *S. obovata* are attributed to habitat degradation by feral pigs and lack of seedling survival due to slug herbivory (Wagner et al 2005). We believe that ongoing threats, if not addressed, are likely to further imperil *Schiedea* species in the action area.

<u>Conclusion</u>

Based on the analysis above, the Service anticipates that stressors associated with training-related wildland fire, and the introduction and spread of invasive species, are likely to result in the reduced fitness of individual plants and decrease the viability of population units of 16 stabilization taxa, by reducing the number of individuals, distribution, and recruitment in the action area. Action area individuals will be exposed to high, low, and very low risks of burning as a result of training-related wildland fire over the next 30 years. The response of stabilization taxa to training-related wildland fire will range from the direct effects of injury and death to the indirect effects of physiological stress, habitat degradation, and competition with non-native species. The overall effect of training-related wildland fire and spread of invasive species will lead to a further decline in individual fitness, baseline number of individuals, and viability of population units within the action area. For each of these 16 stabilization taxa in the action area, the total number of individuals comprises from less than one percent to nearly 100 percent of all known remaining individuals. Thus, reduced viability in action area population units will significantly affect the range-wide status of these 16 taxa.

We develop our opinion using the best available scientific and commercial information, giving benefit of the doubt to the species if significant information gaps preclude determination of quantifiable effects. For example, the proposed action's training-related wildland fire risk could be estimated more accurately with additional modeling to predict long-term fire frequency and encroachment into native forest, and with collection of adequate demographic data for population viability analysis of listed plants. Lacking that information, we infer from restricted distribution, small population size, and limited recruitment that stabilization taxa in the action area have a high background risk of extinction. We believe any additional threats, including training-related wildland fire and habitat degradation by non-native species, are likely to eliminate expectation of long-term persistence for these 16 taxa. Accordingly, we consider stabilization of population units outside the action area, where they will not be exposed to training-related wildland fire, critical to the persistence of these 16 taxa in the wild. Without stable population units outside the action area, reduced viability of action area population units may be sufficient to appreciably reduce the likelihood that these 16 taxa will be conserved.

Our conclusion is based on our best professional judgment of the likely response of the 16 stabilization taxa to both stressors and subsidies of the proposed action. Military training restrictions and conservation management to attain full stabilization will ensure that at least three population units are achieved over the long-term for each taxon, including one or two population units for each taxon outside the action area that will not be exposed to training-related wildland fire. We anticipate that stabilization management will protect these 16 taxa from jeopardy over the next 30 years, while long-term actions for full stabilization are being implemented. Therefore, after reviewing the current status of the 16 stabilization taxa, the environmental baseline for these taxa in the action area, and the effects of the proposed action, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the following 16 stabilization taxa in the wild by reducing their reproduction, numbers, and distribution: *Alectryon macrococcus* var. *macrococcus*, *Cenchrus agrimonioides* var. *agrimonioides*, *Chamaesyce celastroides* var. *kaenana*, *Cyrtandra dentata*, *Dubautia herbstobatae*, *Flueggea neowawraea*, *Hedyotis degeneri* var. *degeneri*, *Hedyotis parvula*, *Hesperomannia arbuscula*, *Melanthera tenuifolia*, *Nototrichium humile*, *Plantago princeps* var. *princeps*, *Pritchardia kaalae*, *Schiedea kaalae*, *Tetramolopium filiforme*, and *Viola chamissoniana* ssp. *chamissoniana*.

EFFECTS OF THE ACTION – *Alectryon macrococcus* var. *macrococcus* (Mahoe)

A total of 273 *Alectryon macrococcus* var. *macrococcus* trees grow on Oahu and 110 individuals on other Hawaiian islands (79 on Kauai, 21 on Maui, and 10 on Molokai). Nineteen percent of all *A. macrococcus* var. *macrococcus* individuals (73 plants) grow in the Makua action area and 17 plants grow in Schofield Barracks West Range (Figure E 13). All known individuals of this species suffer from slight to severe defoliation and reduced vigor due to infestation by the black twig borer, an invasive introduced insect which burrows into branches and introduces a pathogenic fungus to the plants. Chinese rose beetle also defoliates portions of the plants and may kill trees weakened by other threats (Nelson and Davis 1972, and Hara and Beardsley 1979; Mau and Kessing 2004). Rat seed predation and reduced reproduction appear to be the reason that natural recruitment of this species has not been observed (U.S. Army Garrison 2006c). The Army is managing *A. macrococcus* var. *macrococcus* as a stabilization species due to its limited abundance and restricted distribution. Fewer than ten percent of trees in the stabilization population units are considered healthy by Army Natural Resources Staff. Most often, trees have little or no canopy due to black twig borer damage (U.S. Army Garrison 2006c). *Alectryon macrococcus* var. *macrococcus* has a high background risk of extinction due to its very low numbers, low vigor, and insect/pathogen threats.

<u>Species Response to the Proposed Action</u>

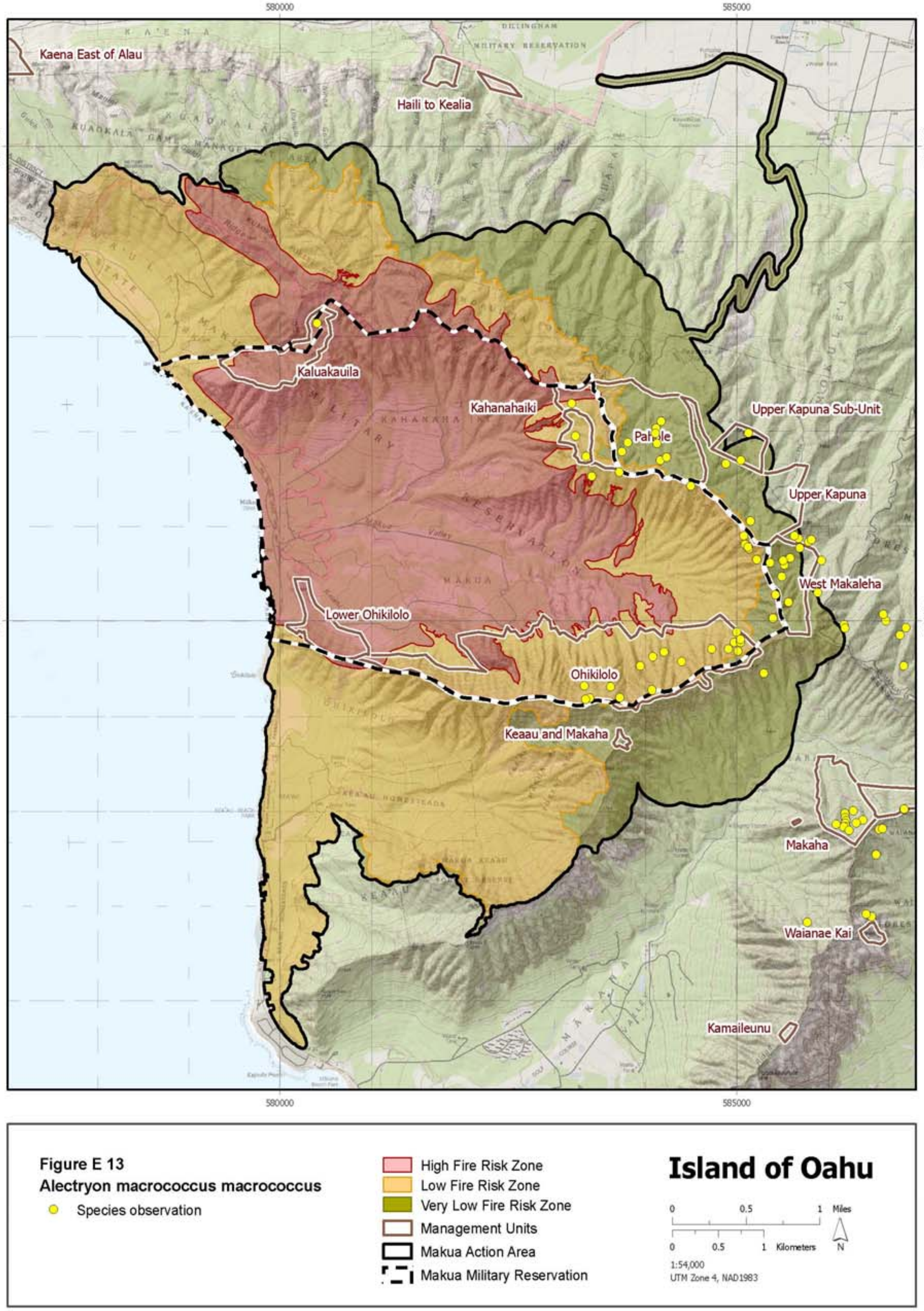
In addition to the insect/pathogen threats to the plants, wildland fires, resulting from the proposed action, could harm or kill the *Alectryon macrococcus* var. *macrococcus* trees in the Makua action area. Twenty two plants grow in the low fire risk zone and 51 individuals occur in the very low fire risk area. Two adult *A. macrococcus* var. *macrococcus* trees persist on the south aspect of C-Ridge, 35 to 150 m (114 to 492 ft) above previously burned grassy slopes. To minimize fire risk to the shrub and forest areas where these trees grow, the Army will utilize targeted aerial herbicide and seeding to discourage grass cover on the previously burned slope on C-Ridge (see Project Description – section 3.1.4.1). Because the shrub and forest vegetation below these plants is also designated Oahu elepaio critical habitat which is slated for restoration if burned, future increases in fire risk to these plants will be minimized. Although this grass control and critical habitat restoration effort will offer some fire protection to these trees, in a large fire, this site will have a lower fire suppression priority than the Kaluakauila and Kahanahaiki areas and these trees may be burned.

Twenty additional trees grow in the low fire risk zone, but their locations behind proposed fuelbreaks, in forested gulches, in high priority fire suppression areas, or at distances greater than 200 m (656 ft) from grass fuels, afford them some protection from training-related fires. These 20 plants (in addition to the 51 individuals occurring in the very low fire risk zone) are also at risk of being impacted by a fire ignited by a misfired long-range, live-fire weapon such as the TOW, and ignitions from a spot fire resulting from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression). However, the one hour of post-training fire detection flights will minimize the likelihood of an undetected fire.

The potential damage to or loss of *Alectryon macrococcus* var. *macrococcus* individuals due to wildland fires associated with live-fire training will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. The Army's black twig borer research and control, propagation and outplanting, and genetic storage efforts will increase this species' likelihood of persistence. The Army is collecting and propagating cuttings and air layers from remaining individuals for the production of new plants and within the next 30 years, outplanting of at least 55 individuals by Army Natural Resources Staff will result in a total of four populations of 50 mature, reproducing *A. macrococcus* var. *macrococcus*. Army Natural Resources Staff have been collaborating with the National Center for Germplasm Research and Preservation, the Harold L. Lyon Arboretum Seed Conservation Lab, and other conservation organizations to develop genetic storage methodology for this species (U.S. Army Garrison 2006c). The Army is studying the soils and pollination systems of several healthy trees in Makaha and Makua Valley which maintain high seed set and fertilization is being examined as a means to increase reproductive effort in declining trees. In addition, research on the black twig borer is being funded by the Army to address this primary threat to the species.

Conclusion

Alectryon macrococcus var. *macrococcus* has a high background risk of extinction due to its very low numbers, low vigor, and insect/pathogen threats. A total of 22 *A. macrococcus* var. *macrococcus* trees are located in the low fire risk zone in the action area and 61 individuals grow in the very low fire risk zone, where they may be injured or killed by fires associated with proposed live-fire training. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning these trees. The potential damage or loss of *A. macrococcus* var. *macrococcus* individuals from training-related wildland fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Within the next 30 years, the Natural Resources Staff will outplant at least 55 *A. macrococcus* var. *macrococcus* individuals, implement black twig borer control, and achieve genetic storage stabilization objectives. Army stabilization efforts will improve the likelihood that *A. macrococcus* var. *macrococcus* will persist over the long term. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.


580000
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Kaena East of Alau
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Kahanahaiki
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Lower Ohikilolo
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Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 13
Alectryon macrococcus macrococcus
Species observation
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
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N
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EFFECTS OF THE ACTION – *Cenchrus agrimonioides* var. *agrimonioides* (Kamanomano)

Of the *Cenchrus agrimoniodes* var. *agrimonioides* on Oahu, 57 percent (401 plants) occur in the action area, in and adjacent to the Kahanahaiki and Pahole Management Units (Figure E 14). The range-wide distribution of this species includes 704 plants on Oahu, and a total of 354 plants on Maui and Lanai (Makua Implementation Team 2003; 68 FR 35970). Seventy-three percent of the Oahu plants (518 individuals) are the result of outplanting efforts by Army Natural Resources Staff and other interagency conservation organizations. All of these individuals are exposed to the suite of threats, including ungulates, described and analyzed in the General Effects section. *Cenchrus agrimoniodes* var. *agrimonioides* has a high background risk of extinction due to its low numbers and ongoing threats, therefore the Army is managing this species as a stabilization species.

<u>Species Response to the Proposed Action</u>

There are 369 naturally occurring and augmented *Cenchrus agrimonioides* var. *agrimonioides* plants growing in the low fire risk zone where they may be burned by an Army-caused fire. In the very low fire risk zone where fire impacts are less likely, 29 naturally occurring mature plants and three immature individuals occur. A wildland fire could spread into Kahanahaiki Management Unit from the valley floor, start in Kahanahaiki or Pahole management units from a misfired long-range, live-fire weapon such as the TOW, or start from a spot fire resulting from an intense grass fire in the valley. The Kahanahaiki and C-Ridge fuelbreaks and firebreaks will minimize the threat of fire spread to the management units. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could permit these fires to burn more than 100 acres in a 48-hr period (see General Effects - Fire Suppression). Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *C. agrimonioides* var. *agrimonioides* in the action area.

The potential damage to or loss of *Cenchrus agrimonioides* var. *agrimonioides* individuals from live-fire training will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Over half of the *C. agrimonioides* var. *agrimonioides* on Oahu are the result of outplanting efforts by Army Natural Resources Staff. Outplanting, weed management, ungulate and rat control efforts, and genetic storage by the Army Natural Resources Staff will continue to improve the baseline numbers of this species.

<u>Conclusion</u>

Fifty-two percent of the known Oahu *Cenchrus agrimonioides* var. *agrimonioides* plants occur in the low fire risk zones of the action area and 4 percent grow in the very low fire risk zone. The Army's training related impacts to this species will be offset by completing stabilization actions including outplanting, weed management, fence installation and ungulates and other invasive species threat control. The Army's management actions for this species will increase the abundance of the plants in the population units within the Waianae Mountain Range over time. While any loss of individual plants could be significant to the survival of *C. agrimonioides* var.

agrimonioides as a taxon, implementation of stabilization actions, including outplanting, ungulate control, fire suppression assistance and genetic storage, are expected to increase vigor and distribution of this species and thus its long-term survival. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits to this species of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Cenchrus agrimonioides* var. *agrimonioides* Critical Habitat

Fifteen percent (189 ha; 467 ac) of the critical habitat designated for *Cenchrus agrimonioides* var. *agrimonioides* is located in one unit within the Makua action area (see Figure E 14). This critical habitat is a portion of a larger 529 ha (1,306 ac) critical habitat unit that extends outside the Makua action area. Located in the northeastern portion of the action area, the entire critical habitat unit is in two low fire risk zones with 14.84 ha (36.67 ac) in the low and 173.96 ha (429.87 ac) in the very low fire risk area. The entire critical habitat unit was designated to provide habitat for the conservation of four populations, with at least 300 mature, reproducing individuals of *C. agrimonioides* var. *agrimonioides* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, dry ridges upper slopes, or ridges in lowland mixed mesic forest (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include native plant species found within a lowland mixed mesic forest community on Oahu. It is estimated that more than one-half of the critical habitat for *C. agrimonioides* var. *agrimonioides* is located in an area with at least 50 percent native plant cover, indicating that habitat quality has declined due to the encroachment of non-native plants. Fire would remove the remaining vegetative primary constituent elements, further degrading the habitat. Once a fire has moved through an area, non-native plant species outcompete the native plants, thereby precluding natural recruitment. In the absence of habitat management, post-burn areas have a denser fuel load, which increases the risk of fire and future habitat loss by the incremental encroachment of subsequent burns into native areas.

The designated unit for *Cenchrus agrimonioides* var. *agrimonioides* is situated approximately in the same location as *Schiedea obovata* and the effects discussion is the same for these two species. There are two small differences between these two critical habitat units: (1) Ninety percent (169 ha; 418 ac) of the critical habitat for *C. agrimonioides* var. *agrimonioides* is located within Pahole, Upper Kapuna and West Makaleha management units; and (2) the amount of remaining critical habitat (outside the management units) is approximately 18 ha (48 ac) for *C. agrimonioide* var. *agrimonioides*.

<u>Conclusion</u>

The critical habitat unit for *Cenchrus agrimonioides* var. *agrimonioides* in the Makua action area is almost entirely within the low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the adjacent Kahanahaiki Management Unit. In addition, fuel reduction within the management unit will further buffer the critical habitat from fire. The portion of critical habitat within Pahole, West, East and Central Makaleha, and the Upper Kapuna management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. agrimonioides* var. *agrimonioides* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *C. agrimonioides* var. *agrimonioides*.

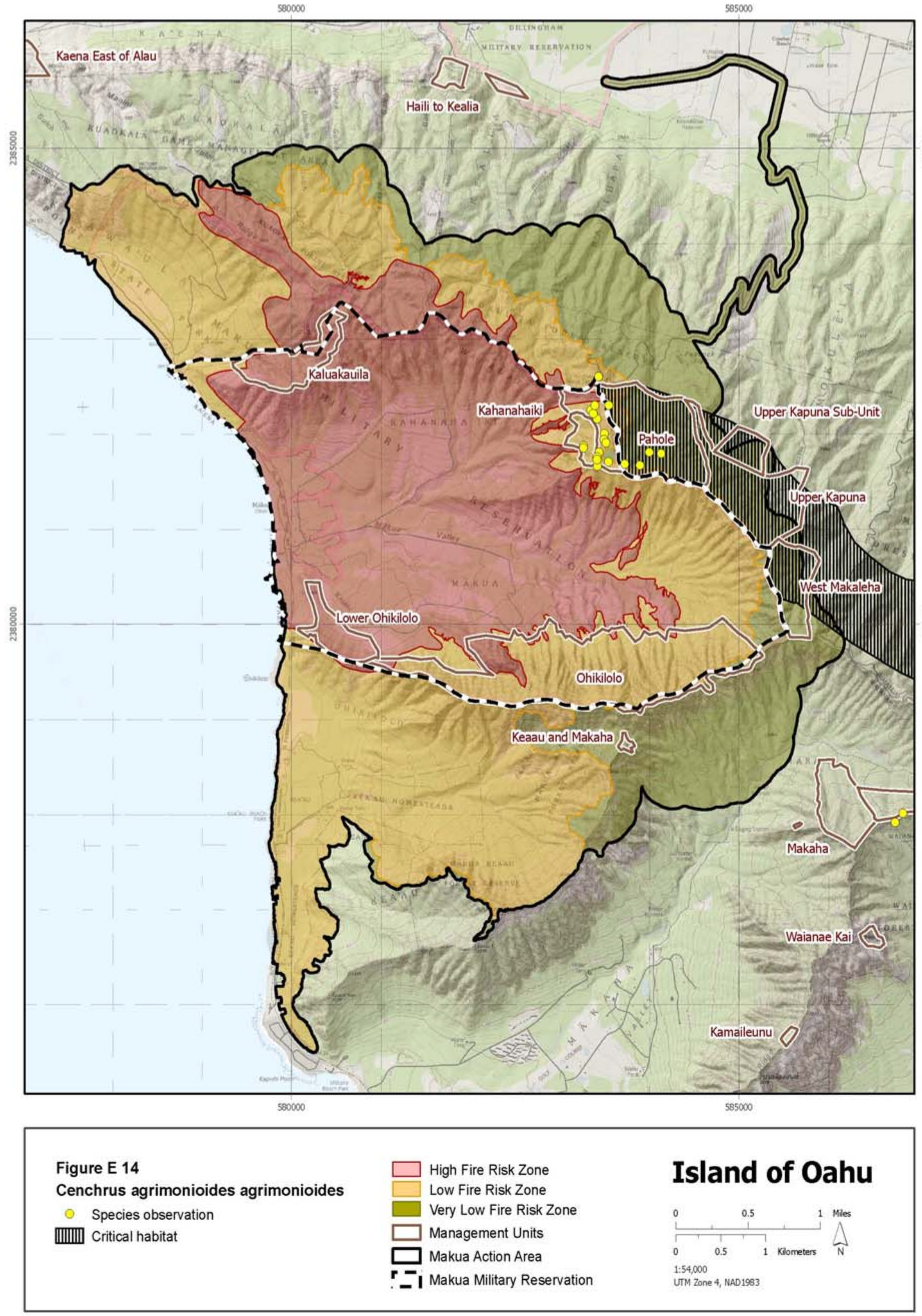


Figure E 14
Cenchrus agrimonioides agrimonioides

EFFECTS OF THE ACTION – *Chamaesyce celastroides* var. *kaenana* (Akoko)

Of the 951 total range-wide individuals of *Chamaesyce celastroides* var. *kaenana*, 513 (54 percent) are located within the Makua action area (Figure E 17). Individuals of this species were first observed in the action area in Lower Ohikilolo Management Unit, in 2001, and upon discovery, there were an estimated 36 individuals (J. Lau, Hawaii Natural Heritage Program, pers. comm. 2001). In addition to the five population units located within the action area, three population units of this Waianae Mountains endemic are found along the Kaena Point cliffs north of the action area, and one population unit is located in the Waianae Kai Forest Reserve south of the action area. Numbers of known individuals have been increasing, primarily as a result of detection of new populations and updated surveys of existing populations. Rats, ungulates, black twig borer, slugs and the Chinese rose beetle are serious threats to *C. celastroides* var. *kaenana*. This species has a high background risk of extinction due to these threats, its range-wide occurrence in dry fire-prone areas, and its low numbers. Between 2005 and 2006, numbers of plants decreased from 19 to 10 in the Kaluakauila Management Unit, due in part to an arson fire ignited at the beach park below the site. The Army is managing this species as a stabilization species pursuant to the Makua Implementation Plan Addendum because of its limited abundance and restricted distribution.

<u>Species Response to the Proposed Action</u>

All 544 plants found within the Makua action area grow in the high fire risk zone, within or adjacent to vegetation that has been converted to grass by previous wildland fires. One hundred and fifty-four *C. celastroides* var. *kaenana* grow in the Lower Ohikilolo Management Unit, 347 plants grow on the cliffs north of Punapohaku Stream (170 on the cliff above Farrington Highway, and 177 in the North Kahanahaiki population unit, in or near steep gulches below Kaluakauila Management Unit), 10 plants occur in the Kaluakauila Stream drainage, and 2 plants grow on C-Ridge (U.S. Army Garrison 2006c). An unknown number of these plants grow on cliffs where they are isolated from flammable vegetation.

High intensity fire kills *Chamaesyce celastroides* var. *kaenana*, although preliminary data indicate that approximately five percent of larger individuals resprout after exposure to low intensity fire (K. Kawelo, Army Natural Resources Staff, pers. comm. 2007). The area in the Lower Ohikilolo Management Unit where 36 *C. celastroides* var. *kaenana* were discovered in 2001 was within the perimeter of a 1998 wildland fire (K. Kawelo, pers. comm. 2007). This site currently supports 154 *C. celastroides* var. *kaenana* shrubs. One of the two plants on C-Ridge was burned in the 2003 escaped prescribed burn and it appears to be recovering, although it is not reproducing (L. Durand, U.S. Army, pers. comm. 2003; U.S. Army Garrison 2004; U.S. Army 2005c).

Fuel reduction treatments, fire suppression staffing, and weapons restrictions were designed to minimize the fire risk to this species. Army Natural Resources Staff clear all grass from within 2 m (7 ft) of the 154 *C. celastroides* var. *kaenana* in the Lower Ohikilolo Management Unit. Grass is also reduced to less than 20 percent cover within weed control areas surrounding these plants in order to minimize fire spread in this area.

Although weapons restrictions and fire suppression staffing will reduce the likelihood of fires escaping initial attack, without the proposed fuels treatments the Punapohaku area is likely to be burned in large fires at Makua (see General Effects – Fire Suppression). To further reduce the likelihood of a training related fire from burning the 347 *Chamaesyce celastroides* var. *kaenana* (which account for 36 percent of all known individuals of this species) growing on the slopes in the Punapohaku Stream, the Army proposes to institute one of several alternative measures, including fuelbreaks and additional stabilization measures (see Project Description section 3.1.4.2). The 10 *C. celastroides* var. *kaenana* growing in the Kaluakauila drainage would also benefit from these proposed fuels treatments.

Chamaesyce celastroides var. *kaenana* will be stabilized pursuant to the Makua Implementation Plan Addendum. Army stabilization will result in 25 reproducing individuals in four threat controlled population units and genetic storage for this species. Three stabilization population units currently meet numerical criteria for stability and one population unit has only 21 out of the necessary 25 mature, reproducing individuals. Augmentation is not currently planned for the stabilization populations because numerical criteria for stability are expected to be achieved through natural recruitment. The fire threat will be controlled with grass clearance adjacent to all stabilization individuals, fire suppression assistance to the State and City and County (Beavers 2007), and future management unit level fuels management. Approximately 219 plants grow within management units where they will benefit from landscape-level weed control. Rats, ungulates, black twig borer, slugs and the Chinese rose beetle are serious threats to *C. celastroides* var. *kaenana*. The Army is funding black twig borer research to develop black twig borer control methods. Ungulate removal from Makua Valley and the Waianae Kai Management Unit will benefit the plants at these sites. In addition, Army Natural Resources Staff have collected seeds from over 100 *C. celastroides* var. *kaenana* plants outside of the action area where fire risk is also high (U.S. Army Garrison 2006c).

<u>Conclusion</u>

Chamaesyce celastroides var. *kaenana* grows in xeric lowland habitat susceptible to wildland fire. Fifty-four percent of these plants occur within the Makua action area. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning most of the *C. celastroides* var. *kaenana* in the action area. To prevent Army live-fire training related fire from burning the *C. celastroides* var. *kaenana* growing on the slopes in the Punapohaku Stream the Army proposes to institute one of several alternative measures, including fuelbreaks and additional stabilization measures (see Project Description section 3.1.4.2). Fencing and ungulate control, weed control, and genetic storage are expected to increase baseline conditions for this species. Management unit level fire protection will provide long-term protection to the *C. celastroides* var. *kaenana* occurring within all management units. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Chamaesyce celastroides* var. *kaenana* Critical Habitat

There are three critical habitat units within the Makua action area, comprising six percent (30 ha; 73 ac) of the State-wide critical habitat for *Chamaesyce celastroides* var. *kaenana* (see Figure E 15). Two units are located in the high fire risk zone. Critical habitat unit B was designated to provide habitat necessary for the conservation of one population of *C. celastroides* var. *kaenana*, unit D was designated to provide habitat necessary for the conservation of a portion of one population and unit A was designated to provide habitat necessary for the conservation of two populations. Each population will be comprised of at least 300 mature reproducing individuals of this species (68 FR 35950). The primary constituent elements that are essential for this species include, but are not limited to, windward talus slopes, leeward rocky cliffs, open grassy slopes, or vegetated cliff faces in coastal dry shrubland. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a coastal dry shrubland community. It is estimated that 78 percent of the critical habitat is located in an area with less than 25 percent native plant cover (K. Kawelo, pers. comm. 2004). This indicates that these critical habitat units are degraded due to non-native plant encroachment. Although degraded, unit B still supports individuals of *C. celastroides* var. *kaenana* and provides habitat that is necessary for the expansion of this population in order to meet the recovery goals for this species. Unit D, currently unoccupied, provides a portion of the habitat necessary for the establishment of an additional population of *C. celastroides* var. *kaenana* in order to meet the recovery goals for this species on Oahu. Portions of unit B have been impacted by past fires which have diminished the conservation value of this habitat. The loss of vegetative primary constituent elements from fire and subsequent invasion by non-native plants precludes natural recruitment. In the absence of habitat management, additional fires from future training actions could add to the degradation of these critical habitat units.

Critical habitat unit B is approximately 4 ha (10 ac), and less than one-half ha (1 ac) of this unit is located in the Kaluakauila Management Unit. Due to the occurrence of this unit in the high fire risk zone, there is a risk that a fire started in the impact area could move north and impact this unit. The risk is increased due to the surrounding vegetation that is dominated by *Panicum maximum*, which is highly flammable and can increase the frequency and size of wildland fires (Beavers et al 1999). The loss of vegetative primary constituent elements within this unit would remove the ability of this unit to provide for the conservation of one population of *Chamaesyce celastroides* var. *kaenana*. To reduce the risk of fire to listed species and sensitive habitats, the Army has prepared a fire management plan for the Kaluakauila Management Unit (see Project Description). Implementation of this plan will reduce the risk of fire due to the construction of a fuel modification zone between the impact area and the management unit. Fuel modification will buffer the Kaluakauila Management Unit from fires that spread outside the impact area and in turn help reduce the probability that critical habitat unit B will burn. In addition, this management unit is currently fenced and the Army is working to reduce non-native plants within the enclosure. The removal of ungulates and non-native invasive plant species within this management unit enhances the conservation value of the critical habitat unit B. The remaining critical habitat (outside of the management unit) is separated from the impact area by the management unit. The fuel modification activities plus other conservation measures implemented by the Army for species stabilization will further reduce the risk of fire to the portion of the critical habitat outside of the management unit.

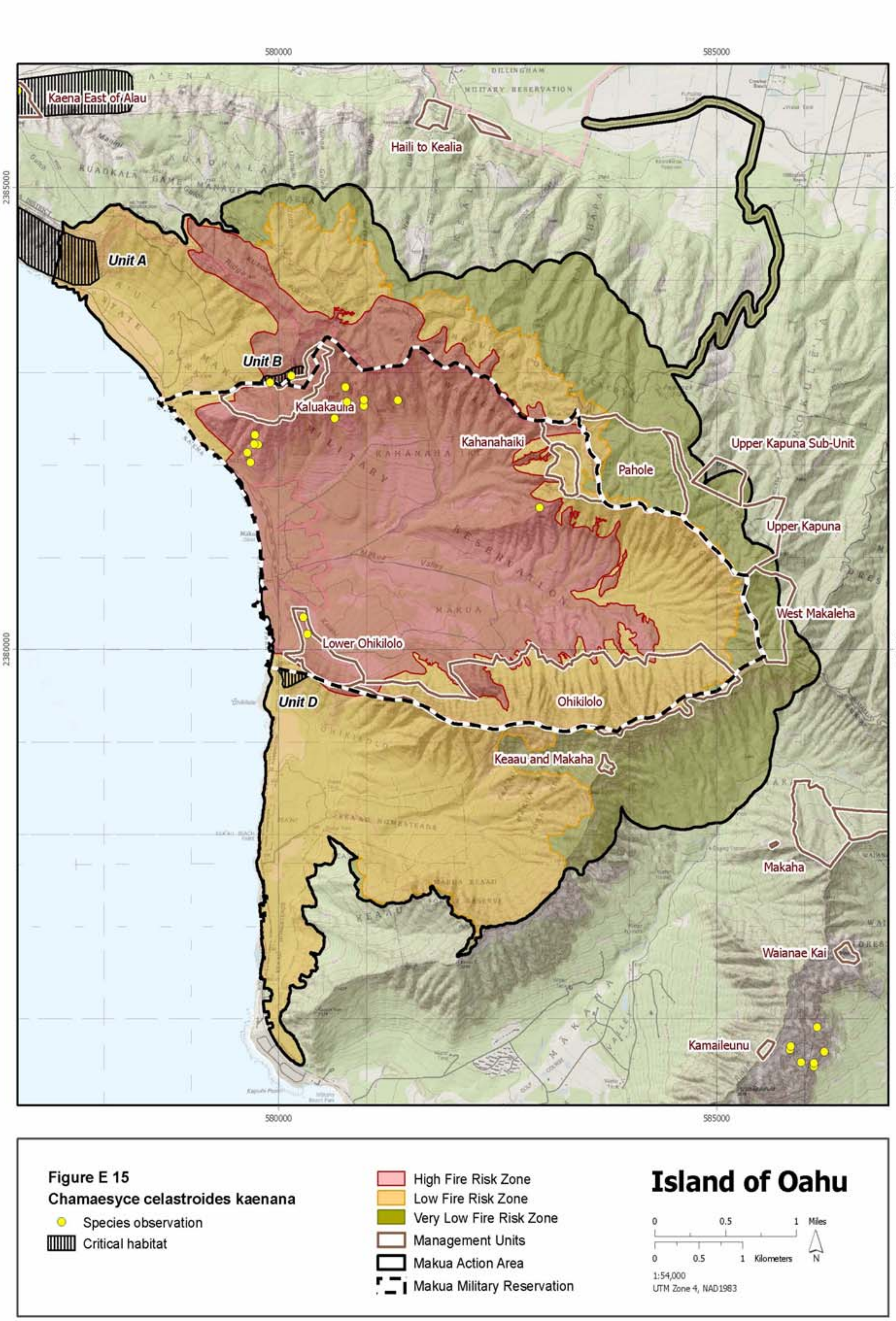
Critical habitat unit D (4 ha; 10 ac) is located south of the Lower Ohikilolo Management Unit. A small sliver of unit D abuts the high fire risk zone and the risk of fire in this xeric, lowland grassland habitat is high. A prescribed burn in 2003 encroached within 0.3 km (0.2 mi) from unit B (G. Enriques, U.S. Army Garrison, Fire Chief, pers. comm. 2003). The consequence of this fire is the encroachment of non-native grassland that provides more flammable fuel and increases the potential for fires in the future. Presently fuel modification is being conducted along the ridgeline between the management unit and the installation boundary to reduce the risk of fire in this area. The loss of vegetative primary constituent elements within this unit would remove its ability to provide a portion of the habitat for one population of *Chamaesyce celastroides* var. *kaenana*. In the Lower Ohikilolo Management Unit, the Army is reducing non-native plants pursuant to the objectives in the Makua Implementation Plan. This action will decrease the risk of fire within the management unit by reducing the fuel load in the area.

A third critical habitat unit (A) is located in the northwestern portion of the Makua action area. This unit totals 231 ha (571 ac). Nine percent (22 ha, 54 ac) of this unit is located within the action area, though none of this unit is located in a management unit. This unit is located in the low fire risk zone and is one km from the high fire risk zone. In addition, as already discussed for critical habitat unit B, a fuel management plan has been prepared and will be implemented to address fuel modification along the northern portion of this unit. This will further reduce the risk of wildland fire encroaching into this management unit.

To reduce the negative impacts to these three critical habitat units from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and the control of non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the revegetation process, the ability of these units to provide habitat essential for the conservation of two populations of *C. celastroides* var. *kaenana* will be retained in the long-term.

Conclusion

The critical habitat units for *Chamaesyce celastroides* var. *kaenana* in the Makua action area are located both inside, and outside the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of fuel modification zones between the impact area and their respective management units. In addition, fuel reduction within the management units will further buffer units A, B and D from fire. The portion of critical habitat unit B that is within Kaluakauila Management Unit will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *C. celastroides* var. *kaenana* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. celastroides* var. *kaenana* and allow for the long-term recovery goals of this species. Therefore, training-related fire events would not result in adverse modification of critical habitat for *C. celastroides* var. *kaenana* because the potential temporal loss of two percent of the critical habitat for *C. celastroides* var. *kaenana* would not preclude its recovery.


580000
585000
2385000
2380000
Kaena East of Alau
Haili to Kealia
Unit A
Unit B
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Unit D
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 15
Chamaesyce celastroides kaenana
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Cyrtandra dentata* (Haiwale)

Approximately 92 percent of all *Cyrtandra dentata* plants (1,396 out of 1,525) grow in the action area in the Kahanahaiki, Pahole, and Kapuna population units (Figure E 16). Two smaller population units of this Oahu endemic, containing a total of 125 *C. dentata* plants occur in the Koolau Mountains, outside the action area (U.S. Army 2006). Total numbers of plants of this species have increased as a result of successful stabilization actions recently conducted by the Army. *Cyrtandra dentata* has a high background risk of extinction due to its very low numbers, limited distribution, and reduced vigor due to competition from invasive exotic plants and impacts from ungulates, slugs and snails. The Army is managing this species as a stabilization species due to its limited abundance and restricted distribution.

<u>Species Response to the Proposed Action</u>

There are 240 *Cyrtandra dentata* plants growing in low fire risk zone in the action area where they may be burned by an Army-caused fire and 1,156 plants in the very low fire risk zone where fire impacts are expected to be more limited. Two hundred and forty *C. dentata* grow in Kahanahaiki Gulch, less than 100 m (328 ft) from the south aspect area of the gulch burned in the 1970, 1984, 1995, and 2003 wildland fires. To minimize the risk of fires in Kahanahaiki Gulch, the Army will construct either a 20-m (65-ft) wide firebreak, or a 200-m (656-ft) wide shaded fuelbreak in Kahanahaiki Gulch along the Kahanahaiki Management Unit perimeter. In addition, a helispot will be maintained within 500 m (1,640 ft) of the upper reaches of Kahanahaiki Gulch and a safety zone will be established within or adjacent to the management unit so that skilled NWCG-qualified fireline supervisors and firefighters, including red-carded Army Natural Resources Staff, can be safely stationed at the outplanting site when fire threatens the gulch area. These efforts are likely to result in the prevention of loss of the plants in the Kahanahaiki Gulch area. All *C. dentata* plants growing in the action area may be impacted by spot fires spawned by intense fires burning in Makua valley, or by fires ignited by a misfired long-range, live-fire weapon (such as the TOW). Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac) (see General Effects—Fire Suppression).

The potential damage to or loss of *Cyrtandra dentata* individuals due to Army-caused fires will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Fencing and ungulate control, weed control, slug and snail control research, and genetic storage actions will help ensure the persistence of *C. dentata*. *Cyrtandra dentata* numbers were declining, but recent ungulate control has resulted in a reversal of that trend (Service 2003b; L. Durand, pers. comm. 2004; U.S. Army Garrison 2005c). Approximately 1,208 *C. dentata* individuals currently benefit from weed control, and fencing and ungulate removal.

<u>Conclusion</u>

There are 240 *Cyrtandra dentata* plants growing in low fire risk zone in the action area where they may be burned by an Army-caused fire and 1,156 plants in the very low fire risk zone where fire impacts are expected to be more limited. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *C.*

dentata in the action area. The potential damage or loss of *C. dentata* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Fencing and ungulate control, weed control, slug and snail control research, and genetic storage are expected to result in increased numbers of *C. dentata*. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of Action on *Cyrtandra dentata* Critical Habitat

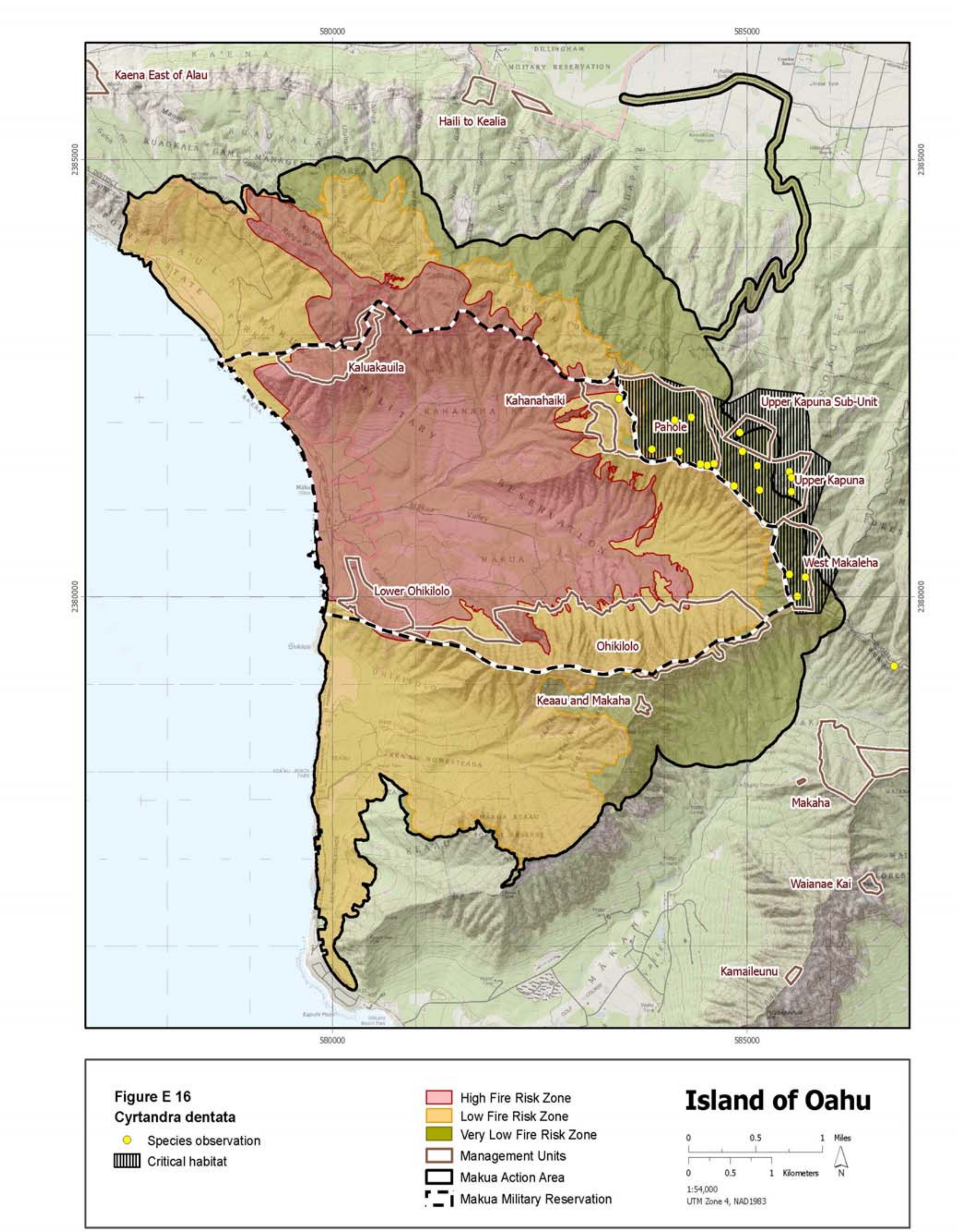
Sixty-eight percent (208 ha; 514 ac) of the critical habitat designated for *Cyrtandra dentata* is located in the Makua action area (see Figure E 16). The unit is located in the northeastern portion of the action area and is almost entirely in the low fire zones, with 17.6 ha (43.6 ac) in the low fire risk zone, 190 ha (470 ac) in the very low zone. This critical habitat, together with 98 ha (243 ac) outside the action area, was designated to provide habitat for the conservation of three populations, each with a minimum of 300 mature individuals of *C. dentata* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, gulches, slopes, stream banks, or ravines in mesic or wet forest. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within mesic or wet forest. It is estimated that more than one-half of the critical habitat is located in forest habitat with greater than 50 percent native plant cover (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004; 68 FR 35950). This indicates that this critical habitat unit still maintains at least half of its native vegetation component although non-native plant encroachment has occurred. Without habitat management, fires could add to the degradation of this critical habitat unit by removing remaining vegetative primary constituent elements in a single burn.

There is a risk that if a fire started in the impact area or if weaponry were misfired, a fire could burn eastward and impact this unit. Eighty-eight percent, or 183 ha (452 ac), of the critical habitat is located in management units (Upper Kapuna, Pahole, West Makaleha, and Upper Kapuna Sub-Unit). The remaining critical habitat (25 ha; 61 ac) outside of the management units is buffered from the impact area by the management units themselves. Please see *Schiedea obovata* for a detailed discussion regarding the reduced risk of fire and the beneficial measures proposed by the Army to offset impacts to this critical habitat unit.

<u>Conclusion</u>

The critical habitat unit for *Cyrtandra dentata* in the Makua action area is located almost entirely in the low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's Standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire to the critical habitat located in the Pahole Management Unit will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit that is adjacent to the Pahole Management Unit. In addition, fuel reduction within the management units will further buffer the critical habitat unit from fire. The critical habitat that is within Upper Kapuna Sub-Unit, Pahole, Upper Kapuna, and West

Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *C. dentata* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. dentata* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *C. dentata*.


Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
580000
585000
2385000
2380000
Figure E 16
Cyrtandra dentata
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Dubautia herbstobatae* (Naenae)

Approximately 98 percent (1,166 out of a total of 1,188) of all *Dubautia herbstobatae* shrubs occur within the Makua action area in the Ohikilolo (1,096 plants) and Keaau (70 individuals) population units (Figure E 17). Two smaller population units of this Waianae Mountains endemic occur in the vicinity of the Makaha and Waianae Kai Management Units. All of these individuals are exposed to the suite of threats, including ungulates and wildland fire described and analyzed in the General Effects section. *Dubautia herbstobatae* has a high background risk of extinction due to its low numbers and threats. The Army is managing this species as a stabilization species because of its limited abundance and restricted distribution.

<u>Analysis of Effects of the Proposed Action</u>

The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Dubautia herbstobatae* individuals in the action area. Approximately 822 *D. herbstobatae* plants are growing in the low fire risk zone of the action area, in the Ohikilolo Management Unit and in the vicinity of the Keaau and Makaha Management Unit. An additional 350 mature plants occur in the very low fire risk zone in Makaha Valley. A wildland fire could spread onto Ohikilolo Management Unit from the valley floor, start on the ridge from a misfired long-range, live-fire weapon such as the TOW, and start from a spot fire resulting from an intense grass fire in the valley. New weapons restrictions and refined fire suppression staffing requirements minimize the risk of fire to the *D. herbstobatae* occurring in Ohikilolo Management Unit. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects—Fire Suppression). The effect of fire on *D. herbstobatae* has not been documented but many individuals in the action area grow on cliffs (U.S. Army Garrison 2006c) where fire spread will be limited.

The potential damage to or loss of *Dubautia herbstobatae* individuals due to wildland fires associated with live-fire training will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. The 84 individuals in the Waianae Kai and Keaau population units are exposed to wildland fires ignited by the public in Waianae Valley and along Farrington Highway (Beavers 2007a). Although the *D. herbstobatae* in the vicinity of the Keaau and Waianae Kai management units are only scheduled for genetic storage protection by Army Natural Resources Staff, these two populations of plants will benefit from the fire suppression, fuels management, control of threats to populations of other species (e.g., *Sanicula mariversa*) located on these sites. Threat control, and, if necessary, outplanting will increase the number of mature, reproducing *D. herbstobatae* in the Makaha population unit by a minimum of 14 plants.

<u>Conclusion</u>

Despite the ongoing exposure of *Dubautia herbstobatae* to wildland fire impacts associated with the proposed project, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fire detection and fire suppression helicopter staffing will minimize the risk of training-related wildland fire to the *D. herbstobatae* occurring in the action area. Stabilization actions, including propagation, augmentation, ecosystem management, and genetic storage scheduled to be conducted by the Army over the next 30 years will increase baseline numbers of *D. herbstobatae* inside and outside the action area. Therefore, based on our analysis of the effects of the actions outlined in the Project Description, including training-related fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Dubautia herbstobatae* Critical Habitat

There are two critical habitat units within the Makua action area, encompassing less than 16 percent (approximately 14 ha; 36 ac) of the total critical habitat for *Dubautia herbstobatae* (see Figure E 17). The entire critical habitat is located in the low fire zones, with 0.31 ha (0.76 ac) in the low fire risk zone and 11.3 ha (27.8 ac) in the very low zone. These units provide habitat for the conservation of a total of three populations in order to meet the recovery goals for this species. Each population will be comprised of at least 300 mature, reproducing individuals of *D. herbstobatae* (68 FR 35950). The primary constituent elements that are essential for this species include, but are not limited to, rock outcrops, ridges, moderate slopes, or vertical cliffs in dry or mesic shrubland (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a dry or mesic shrubland. It is estimated that more than 90 percent of the critical habitat is in forest habitat with less than 25 percent native plant vegetation (K. Kawelo, pers. comm. 2004). This indicates that these critical habitat units are currently degraded due to non-native plant encroachment. However, unit A still supports individuals of *D. herbstobatae* and provides habitat that is necessary for the expansion of this population.

Should a fire from training actions impact one or both of these units, the loss of their vegetative primary constituent elements and the subsequent invasion by non-native plant species will preclude natural recruitment. In the absence of habitat management, these fires could increase the degradation of these critical habitat units by removing the remaining vegetative primary constituent elements.

Critical habitat unit A is approximately 12 ha (29 ac) on Ohikilolo ridge. One hectare (3 ac) of this critical habitat unit is located in Ohikilolo Management Unit within the low fire risk area. Unit A is approximately 0.5 km (0.25 mi) from the high fire risk zone, and there is a risk that a fire started in the impact area could move up Ohikilolo Ridge from the north or the west and impact this unit. The risk is decreased somewhat by the surrounding vegetation composed of mixed cliff communities and *Schinus terebinthifolius* forest, which are of low and moderate fire hazard, respectively, and can slow the fire (Beavers et al 1999). A prescribed burn in 2003 encroached into Ohikilolo Management Unit at the northern edge, opposite the location of the critical habitat unit, which is on the southern edge of the management unit (G. Enriques, pers. comm. 2003). The consequence of this fire is the encroachment of non-native grassland that provides a more flammable fuel and increases the potential risk for future fires in this area. The loss of vegetative primary constituent elements within this unit would remove its ability to provide habitat for the conservation of one population of *Dubautia herbstobatae*. To reduce the risk of fire to listed species and sensitive habitats, the Army will develop and implement a fire management plan for the Lower Ohikilolo Management Unit, including, but not limited to, the construction of a fuel modification line at the base of the management unit. This fuel modification line will buffer the Ohikilolo Management Unit from fires that spread outside the firebreak road from the west up and along Ohikilolo Ridge. In addition, this management unit is currently fenced and goat-free and the Army is working to reduce non-native plants within the fence. The Army is monitoring the impacts of feral pigs and will take further measures to remove pigs if they become a threat to *D. herbstobatae* critical habitat. The removal of ungulates and non-native invasive plant species within this management unit enhances the conservation value of critical habitat unit A. The critical habitat outside of the management unit is buffered from the impact area by the management unit. The fuel modification activities, plus other conservation measures implemented by the Army for species stabilization, will further reduce the risk of fire to the portion of the critical habitat outside of the management unit.

Critical habitat unit C (3 ha; 7 ac) is located within the low fire risk zone near the Keaau and Makaha Management Unit. Unit C is approximately 1 km (0.6 mi) from the high fire risk zone, and the risk of fire in this xeric grassland habitat is high. The 2003 prescribed burn encroached within 1.3 km (0.8 mi) from unit C (G. Enriques, pers. comm. 2003). The consequence of this fire is the encroachment of non-native grasses that provide more flammable fuel and increases the potential for fires in the future. The fuel modification conducted for Unit A will also reduce the risk of fire in this area. The loss of vegetative primary constituent elements within this critical habitat unit would remove its ability to provide for the conservation of two populations of *Dubautia herbstobatae*. In the Upper Keaau Management Unit, the Army will fence and remove ungulates, and reduce non-native plants pursuant to the objectives in the Makua Implementation Plan. In addition, the control of non-native species in the Ohikilolo Management Unit will provide an additional buffer between the Upper Keaau Management Unit and the impact area. These actions will decrease the risk of fire within the management unit by reducing the fuel load in the area.

To reduce the negative impacts to critical habitat from fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The re-vegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the re-vegetation process, the ability of these units to provide habitat essential for the conservation of three populations of *Dubautia herbstobatae* will be retained in the long-term.

Conclusion

One hundred percent of the two critical habitat units for *Dubautia herbstobatae* in the Makua action area is located outside of the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of fuel modification zones between the impact area and their respective management units. In addition, fuel reduction within the management units will further buffer critical habitat units A and B from fire. The portion of critical habitat unit A that is within Ohikilolo Management Unit and the portion of critical habitat unit C within Upper Keaau Management Unit will be managed to improve their baseline quality pursuant to the Makua Implementation Plan. Without this management, these critical habitat units would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued risk of degradation of *D. herbstobatae* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *D. herbstobatae* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *D. herbstobatae.*

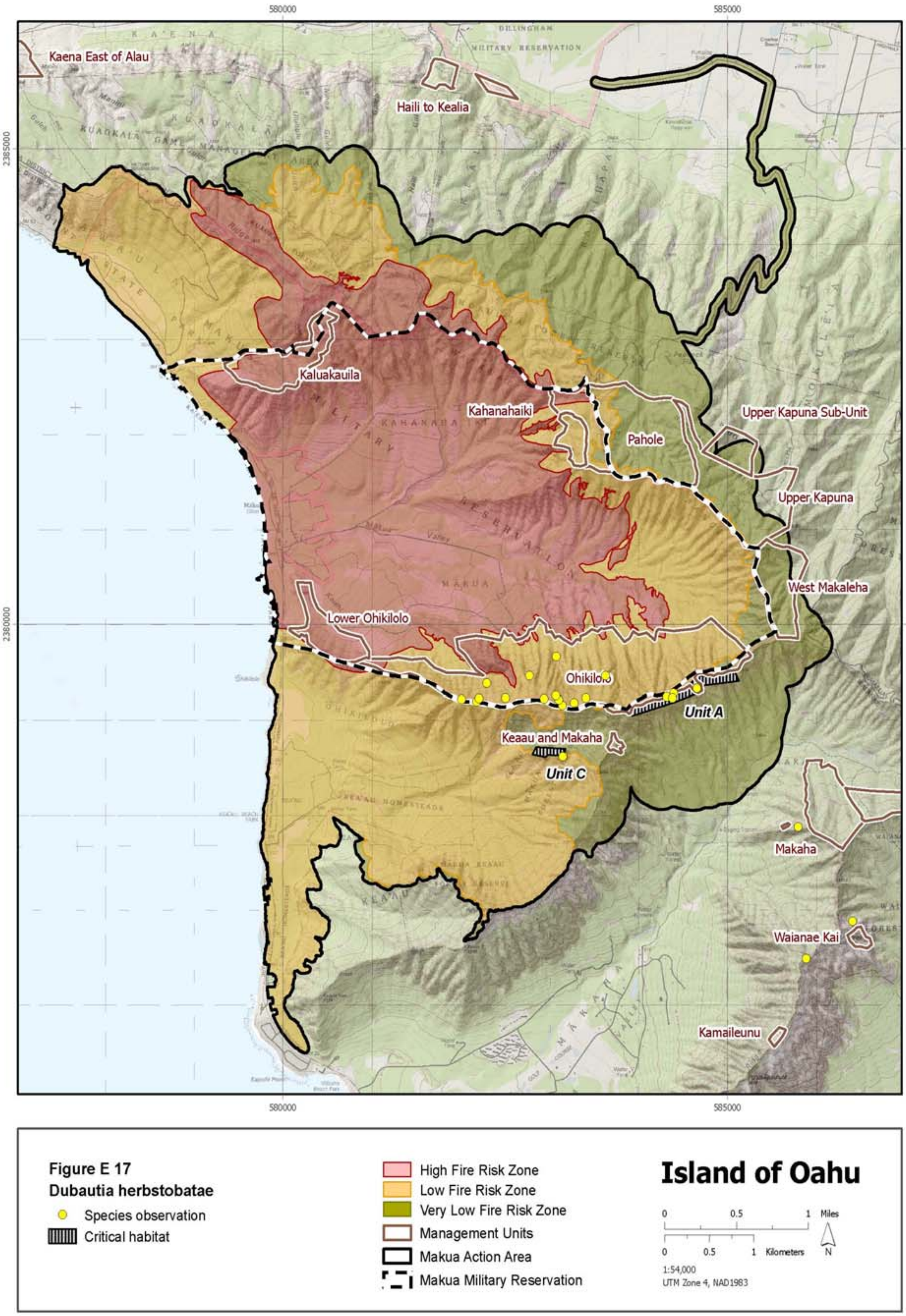


Figure E 17
Dubautia herbstobatae

EFFECTS OF THE ACTION – *Flueggea neowawraea* (Mehamehame)

Flueggea neowawraea is a long-lived tree species with 129 individuals occurring in ten population units on Oahu (Figure E 18). An additional 52 to 59 individuals are located in 39 population units on other Hawaiian Islands. Out of the 129 *F. neowawraea* trees on Oahu, only 40 are naturally occurring adults. However, the Army's Natural Resources Staff have outplanted 59 individuals associated with their stabilization efforts for this species. The remaining 30 trees on Oahu are located in gardens and arboretums. Approximately 33 percent of the range-wide population of *F. neowawraea* (including the naturally occurring adult trees (14) and all 59 of the outplanted saplings) are found in the Makua action area. *Flueggea neowawraea* is not reproducing naturally due to a variety of reproductive challenges including isolation (due to the species inability to self-pollinate) and poor vigor due to black twig borer and Chinese rose beetle damage. *Flueggea neowawraea* has a high background risk of extinction due to its very low numbers, low vigor, and insect/pathogen threats. The Army is managing this species as a stabilization species due to its limited abundance and restricted distribution.

<u>Species Response to the Proposed Action</u>

Four mature, naturally occurring *Flueggea neowawraea* trees and 59 outplanted saplings grow in the low fire risk zone where they may be burned by a training-caused fire. Ten naturally occurring trees are found in the very low fire risk zone within the Makua action area where fire impacts are less likely. Army weapons restrictions, fire suppression staffing, and fuels management projects are designed to minimize the risk of fire damage to the *F. neowawraea* growing within the action area. The effect of fire on *F. neowawraea* has not been documented, but the tree's thin bark is not likely to be adequate to prevent fire injury to the cambium.

The Army Natural Resources Staff have outplanted 59 saplings in mesic gulches in the Kahanahaiki Management Unit to augment the one remnant adult tree in this area. The lower reaches of the Kahanahaiki Gulch and the south aspect of the upper reaches of the gulch burned in the 1970, 1984, 1995, and 2003 wildland fires and all of these fires except for the 1984 fire breeched the Kahanahaiki Management Unit perimeter. To minimize the risk of fires in Kahanahaiki Gulch, the Army will construct either a 20-m (65-ft) wide firebreak, or a 200-m (656-ft) wide shaded fuelbreak in Kahanahaiki Gulch along the Kahanahaiki Management Unit perimeter. In addition, a helispot will be maintained within 500 m (1,640 ft) of the upper reaches of Kahanahaiki Gulch and a safety zone will be established within or adjacent to the management unit so that skilled NWCG-qualified fireline supervisors and firefighters, including red-carded Army Natural Resources Staff, can be safely stationed at the outplanting site when fire threatens the gulch area. These efforts are likely to result in the prevention of loss of the trees and saplings in Kahanahaiki Gulch.

One adult *Flueggea neowawraea* persists on the south aspect of C-Ridge, 35 m (114 ft) above previously burned grassy slopes, where it is partially protected by a forested drainage. To minimize fire risk to the forested area where this tree grows, the Army will utilize targeted aerial herbicide and seeding to discourage grass cover on the previously burned slope on C-Ridge (see Project Description – section 3.1.4.1). Although this grass control effort will offer some fire protection to this tree, in a large fire, this site will have a low fire suppression priority and the tree may be burned.

One *Flueggea neowawraea* tree grows on the steep valley walls in the Ohikilolo Management Unit in the low fire risk zone, and 10 *F. neowawraea* trees grow in the very low fire risk zone. The greatest fire risk to these 11 trees is from misfired long-range, live-fire weapons such as the TOW, and spot fires spawned by intense fires in the lower valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac) (see General Effects - Fire Suppression).

The potential damage to or loss of *Flueggea neowawraea* individuals due to fires associated with live-fire training will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Within the next 30 years, outplanting of at least 84 individuals by Army Natural Resources Staff will result in a total of three populations of 50 *F. neowawraea*. The Army is collecting and propagating cuttings and air layers from remaining individuals for the production of new plants. In addition, research on the black twig borer is being funded by the Army to address this primary threat to this species. Army Natural Resources Staff have currently achieved genetic storage goals for four *F. neowawraea* trees and genetic storage goals are expected to be met for all 40 individuals of this species.

<u>Conclusion</u>

Approximately 73 *Flueggea neowawraea* are located in the low and very low fire risk zones in the Makua action area. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *F. neowawraea* trees. The potential damage or loss of *F. neowawraea* individuals from training-related wildland fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Within the next 30 years, the Natural Resources Staff will outplant at least 84 *F. neowawraea* individuals, implement black twig borer control, and achieve genetic storage stabilization objectives. Army stabilization efforts will improve the likelihood that *F. neowawraea* will persist over the long term. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem managment.

Effects of the Action on *Flueggea neowawraea* Critical Habitat

Six percent (174 ha; 431 ac) of the total critical habitat for *Flueggea neowawraea* is located in the Makua action area (see Figure E 18). The critical habitat is located in the northeastern portion of the action area. The unit straddles all fire risk zones with 157.2 ha (388.5 ac) in the low risk zone; 16.8 ha (41.6 ac) in the very low risk zone and only 0.2 hectares (0.6 ac) in the high fire risk area. The critical habitat in the action area, in combination with 670 ha (1,656 ac) of habitat outside the action area, was designated to provide habitat for the conservation of one population of at least 100 mature individuals of *F. neowawraea* (68 FR 35950). The physical and biological habitat features (primary constituent elements) essential for this species include, but are not limited to, gulch slopes, ridge crests, or near streams in dry or mesic forest (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a dry or mesic forest community. It is estimated that a little more than one-half of the critical habitat is located in forest habitat with greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004). This indicates that the habitat in this unit retains some native components but that the area has been impacted by invasive non-native plants. Portions of this critical habitat unit may have been impacted by past fire events, which diminishes the conservation value of the habitat by removing the vegetative primary constituent elements. Non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

A prescribed burn in 2003 appears to have breached the northwestern-most portion of the critical habitat unit. The consequence of this fire is the encroachment of non-native mixed grassland (*Leucaena leucocephala*/*Panicum maximum*; koa haole/guinea grass) that provides flammable fuel and increases the potential for fires to creep into the critical habitat unit in the future. The eventual loss of this portion of the critical habitat unit would reduce its ability to provide a portion of the habitat necessary for the conservation of one population of *Flueggea neowawraea*. However, only 0.2 ha (0.6 ac) of this unit are in an area of high fire risk and most of the unit's western boundary is immediately adjacent to low and very low fire risk areas.

The critical habitat in the high fire risk area is adjacent to the Kahanahaiki and Pahole management units. Approximately 70 percent or 246 ha (607 ac) of the critical habitat in the action area is found within management units (Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, and West Makaleha). Less than one ha (2 ac) of critical habitat is in the Kahanahaiki, Central, and East Makaleha management units. The implementation of increased fire suppression measures pursuant to this consultation (e.g., helicopter staffing, fuel modification, weapons restrictions) will further reduce the risk of fire to *Flueggea neowawraea* critical habitat. In addition, construction of the fuelbreak will buffer the Kahanahaiki Management Unit from fires that spread outside the impact area (see General Effects-Fire) and, in turn, reduce the probability that fire will burn through the management unit and into the critical habitat in the Pahole Management Unit, which is immediately adjacent. The boundary of this critical habitat unit abuts areas of low and very low fire risk vegetation (mostly native forest).

For other conservation actions that have been or will be implemented pursuant to the Makua Implementation Plan, please see the discussion for *Schiedea obovata*. The remaining critical habitat outside the management units (104 ha; 257 ac) is separated from the impact area by low and very low fire risk areas and by the above-mentioned management units themselves. Spatial separation from the impact area, adjacent low and very low fire risk area along the western boundary of the critical habitat unit, fuel modification actions that will be implemented for the Kahanahaiki Management Unit, and the aforementioned activities implemented by the Army for species stabilization in the Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, West, Central and East Makaleha, and Kahanahaiki management units will further reduce the risk of fire to the portion of critical habitat outside the management units.

Conclusion

The critical habitat unit for *Flueggea neowawraea* in the Makua action area is mostly within the low and very low fire risk area. A small portion (close to zero percent) is within the high fire risk area, and this portion is buffered by fuel reduction actions in the adjacent Kahanahaiki and Pahole management units. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit. Implementation of the all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside the firebreak road or that a misfired round will ignite outside of the firebreak road. The portion of critical habitat within the Kahanahaiki, Pahole, West, East and Central Makaleha, and Upper Kapuna, Upper Kapuna Sub-Unit management units will be managed to improve its baseline quality pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *F. neowawraea* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *F. neowawraea* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modifications to *F. neowawraea* critical habitat.

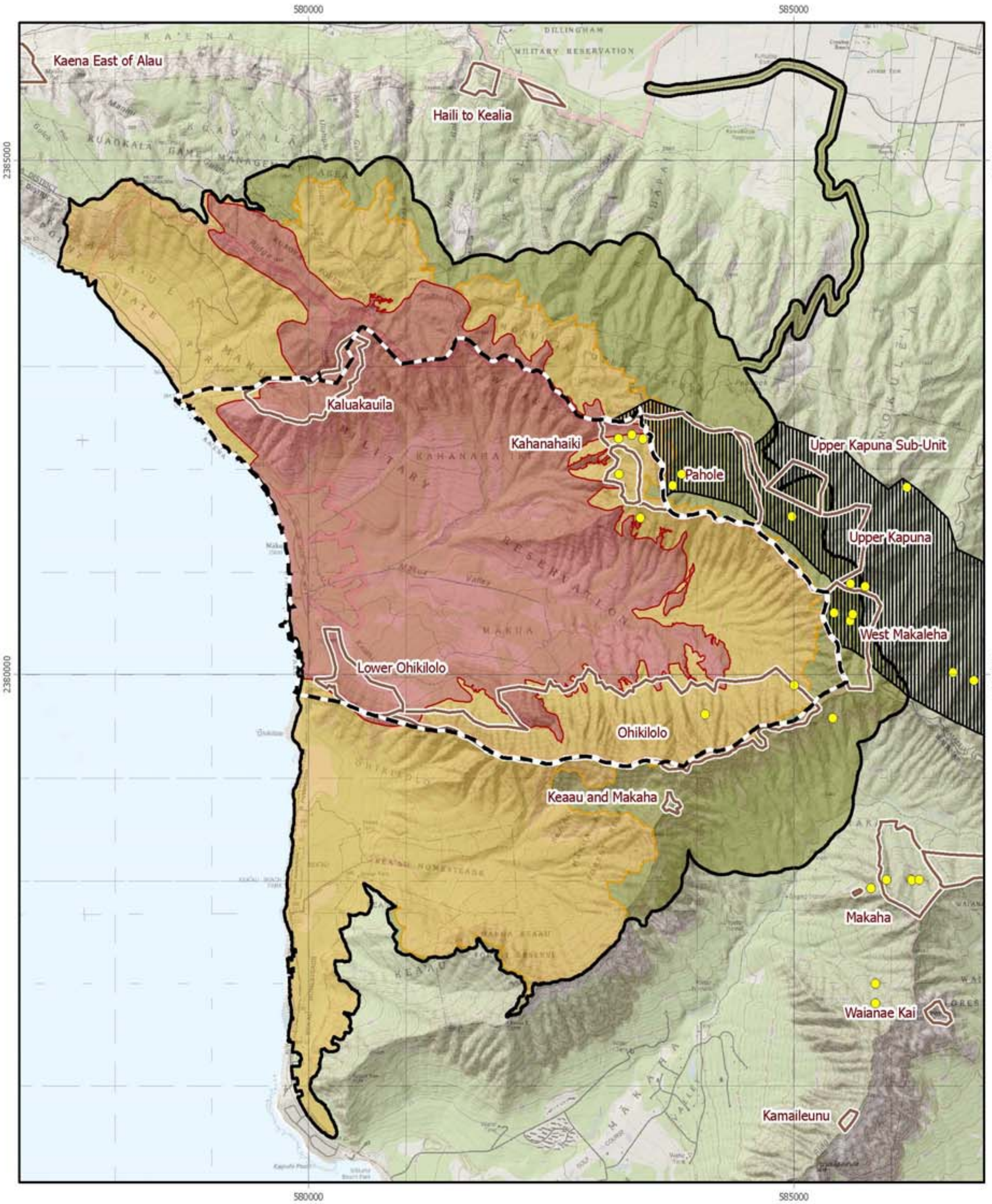


Figure E 18
Flueggea neowawraea

- Species observation
- Critical habitat

- High Fire Risk Zone
- Low Fire Risk Zone
- Very Low Fire Risk Zone
- Management Units
- Makua Action Area
- Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Hedyotis degeneri* var. *degeneri* (No Common Name)

Hedyotis degeneri var. *degeneri* is endemic to the Waianae mountain range of Oahu and 85 percent of all known individuals (524 out of a total of 617 recorded range-wide individuals) grow in the Kahanahaiki and Pahole management units in the action area (U.S. Army Garrison 2006c) (Figure E 19). Although plant numbers have quadrupled in recent years, this is due to the discovery of new plants; ungulate and weed threats are actually resulting in reductions in numbers (S. Ching, Army Natural Resources, pers. comm. 2007). *Hedyotis degeneri* var. *degeneri* has a high background risk of extinction due to ongoing threats and its low numbers. The Army is managing this species as a stabilization species pursuant to the Makua Implementation Plan Addendum due to its limited abundance and restricted distribution.

Species Response to the Proposed Action

The proposed action could result in injury and death of *Hedyotis degeneri* var. *degeneri* individuals in the action area. A total of 259 plants (42 percent of all range-wide individuals) grow in the low fire risk zone of the Makua action area and there are 265 individuals (accounting for an additional 43 percent of all plants) in the very low fire risk zone in the Pahole Management Unit. Six mature shrubs grow within approximately 30 m (98 ft) of a grassy slope where forest and shrub vegetation was burned by the Army's 1995 and 2003 escaped prescribed burns. The Army will construct and maintain a new 40-m (131-ft) wide fuelbreak to minimize fire risk to Kahanahaiki (see Figure PD 8), and this site will receive high priority by fire suppression helicopters and skilled fireline supervisors (see General Effects - Fire Suppression). This fuelbreak is not likely to be substantial enough to prevent accidental or white phosphorus-caused wildland fires, which may occur when Makua is not staffed by fire suppression resources, from impacting this area of Kahanahaiki Management Unit. Fire risk to the 265 plants growing in the low fire risk zone in Pahole Management Unit will be minimized by the Army's maintenance of the 200-m (656-ft) shaded fuelbreak on C-Ridge, below the management unit (see Project Description section 3.1.3). All plants in the action area may be burned in a fire ignited on the ridge by a misfired long-range, live-fire weapon such as the TOW, or by a spot fire resulting from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression).

The potential damage to or loss of *Hedyotis degeneri* var. *degeneri* individuals due to wildland fires associated with live-fire training will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Stabilization actions proposed by the Army, including outplanting, ungulate control, weed control and genetic storage, are likely to result in increased probability that this species will persist. Fencing and ungulate control (scheduled for completion in 2008 in the East Makaleha Management Unit, 2012 in the Manuwai Management Unit, and five years after the completion of this Biological Opinion in Kahanahaiki Management Unit) and ecosystem-level weed control is likely to result in increased vigor and reproductive success of the *H. degeneri* var. *degeneri* at these sites, and will improve site quality for outplanted individuals. The Army has already met genetic storage goals for 23 out of the 135 plants slated for this protection.

Conclusion

Hedyotis degeneri var. *degeneri* has a high background risk of extinction due to its low numbers, which are declining as a result of ungulate and weed impacts. Approximately 42 percent of all range-wide individuals are located in the low fire risk zone in the action area and an additional 43 percent of all plants grow in the very low fire risk zone, where they may be injured or killed by fires associated with proposed live-fire training. Weapons restrictions, fire detection and fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning the plants in the action area. The potential damage or loss of *H. degeneri* var. *degeneri* individuals from training-related wildland fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Stabilization actions proposed by the Army, including outplanting, ungulate control, weed control, and genetic storage, significantly increased the probability that this species will persist over the long term. Based on our analysis of the effects of the actions outlined in the Project Description including wildland fire minimization measures, the Service believes that the risks associated with the Army's proposed action, which are low to very low, are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Hedyotis degeneri* var. *degeneri* Critical Habitat

Approximately 23 percent, or 212 ha (524 ac), of the total critical habitat for *Hedyotis degeneri* is located in one unit in the Makua action area (see Figure E 19). The critical habitat in the action area is a portion of 917 ha (2,265 ac) that were designated to provide habitat for the conservation of eight populations of *H. degeneri*. Each population will be comprised of at least 300 mature individuals in order to meet the recovery goals for this species. As with many other species previously discussed, this critical habitat for *H. degeneri* is located in the northeastern portion of the action area, almost entirely in low fire risk zone, with 16.7 ha (41.3 ac) in the low fire risk area and 195 ha (482 ac) in the very low fire risk area. The primary constituent elements essential for this species include, but are not limited to, ridge crests in diverse mesic forest (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a diverse mesic forest community on Oahu. It is estimated that 70 percent of the critical habitat is located in forest habitat with greater than 50 percent native plant cover, indicating this area still supports a relatively healthy native forest. However, invasive plant species have encroached into this area, and their ability to outcompete native plants slowly degrades native ecosystems. In the absence of resource management, additional fires or even threats from invasive plants and animals add to the incremental degradation of this critical habitat unit by removing vegetative primary constituent elements.

The risk of a training-related fire moving east from the impact area and burning this critical habitat unit is low. Eighty-seven percent or 246 ha (607 ac) of the critical habitat is located in designated management units (Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, Central and West Makaleha, Kahanahaiki, and West Makaleha). Please see *Schiedea obovata* for a detailed discussion regarding the ongoing or proposed Army actions to benefit the aforementioned management units. The amount of critical habitat for *Hedyotis degeneri* outside of the management units is approximately 37 ha (91 ac). This area is separated from the impact area by low and very low fire risk areas and by the above-mentioned management units themselves. Therefore, spatial separation from the impact area, adjacent low and very low fire risk areas along the western boundary of the critical habitat unit, fuel modification actions that will be implemented for the Kahanahaiki Management Unit, and the activities discussed previously (*S. obovata* effects analysis) will further reduce the risk of fire to all critical habitat for *H. degeneri*.

<u>Conclusion</u>

The critical habitat unit for *Hedyotis degeneri* in the Makua action area is almost entirely within the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit. In addition, fuel reduction within the management units will further buffer the critical habitat unit from fire. The portion of critical habitat within Pahole, Kahanahaiki, West, East and Central Makaleha, and Upper Kapuna management units will be managed to improve its baseline quality pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). The Service considered this continued degradation of *H. degeneri* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *H. degeneri* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *H. degeneri*.

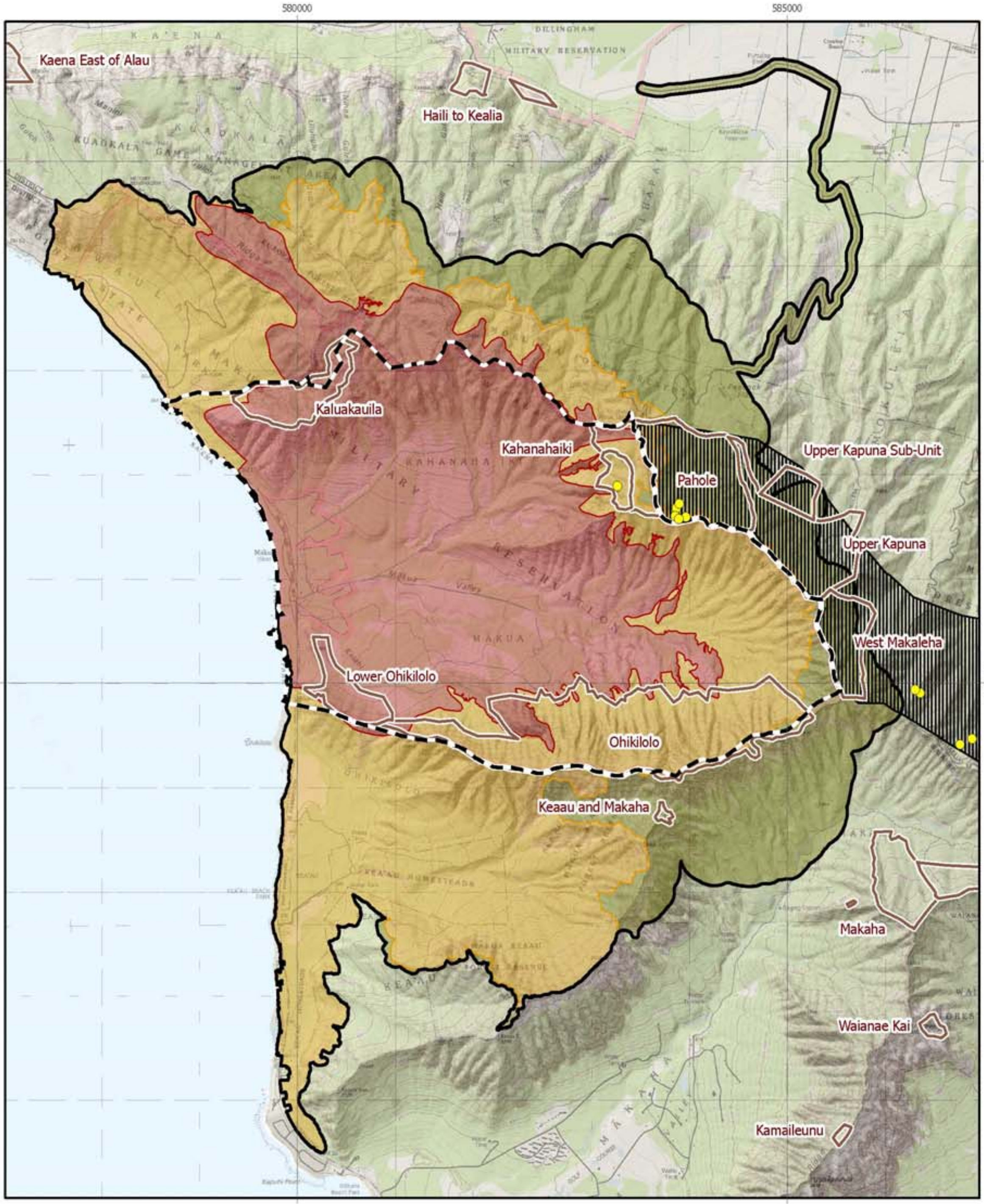


Figure E 19
Hedyotis degeneri degeneri

Species observation
Critical habitat

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Hedyotis parvula* (No Common Name)

There are 188 *Hedyotis parvula* in the action area located in the Ohikilolo Makai and Ohikilolo Mauka population units (Figure E 20). *Hedyotis parvula* is endemic to the Waianae Mountain Range of Oahu and 418 total individuals are known to grow in the wild. Recent wildland fires in Nanakuli and Lualualei burned close to the Halona population unit. Herbivory by ungulates and invasive plants also impact this species throughout its range (U.S. Army Garrison 2006c). We infer from these circumstances, conservation biology principles, and examples from other species that *H. parvula* has a high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence. Therefore, the Army is managing *H. parvula* as a stabilization species pursuant to the Makua Implementation Plan Addendum.

<u>Species Response to the Proposed Action</u>

The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Hedyotis parvula* individuals in the action area. All individuals (188 plants, representing 45 percent of all range-wide individuals) grow along the outer edges of the low fire risk zone within the Ohikikilolo Management Unit (Figure E 20). These plants may be burned in a fire ignited on the ridge by a misfired long-range, live-fire weapon such as the TOW, or from a spot fire resulting from an intense grass fire in the valley where fires escaping initial attack in the lower valley may reach them. However, all individuals are located high on the cliffs, farther than 300 m (984 ft) from the grass slopes in the lower valley (see General Effects – Fire Suppression). Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression).

The potential damage to or loss of *Hedyotis parvula* individuals due to wildland fires associated with live-fire training will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Stabilization actions that include outplanting, ungulate control, Army fire suppression assistance, and genetic storage, increases the probability this species will persist in the long term. The high risk of fire to the Halona population unit (outside the action area) will be minimized by Army wildland fire suppression and fuels management efforts (Beavers 2007a). Ungulate control at the Ohikilolo Management Unit, and fencing and ungulate control conducted by the Army at the Palekea Management Unit (scheduled for 2009) will provide further protection to this endangered species.

<u>Conclusion</u>

Despite the ongoing exposure of *Hedyotis parvula* to project wildland fire impacts, fire risk to this species is very low, and Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. The potential damage or loss of *H. parvula* individuals from fire will be offset by the ongoing efforts of the Army Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Fencing and ungulate control, weed control, fire suppression assistance, and genetic storage are expected to result in increased likelihood that *H. parvula* will persist inside and outside the action area. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Hedyotis parvula* Critical Habitat

There is one critical habitat unit within the Makua action area, representing one percent (7 ha; 17 ac) of the total critical habitat for *Hedyotis parvula* (see Figure E 20). This critical habitat is part of a larger 387 ha (958 ac), critical habitat unit that includes habitat outside the Makua action area (Figure 27). All critical habitat for this species is found inside the very low fire risk zone, with 6.67 ha (16.47 ac) in the unit. This unit and the 382 ha (945 ac) of habitat outside the action area was designated to provide habitat for the conservation of a total of four populations, each comprising at least 300 reproducing individuals of *H. parvula* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, cliff faces or their bases, rock outcrops, or ledges in mesic habitat (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within mesic habitat. On Oahu, it is estimated that more than 80 percent of the forest habitat in the action area has more than 75 percent native plant cover (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that there is relatively little non-native plant encroachment in this unit. Fire removes the vegetative primary constituent elements and non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

The critical habitat unit is approximately 3 km (2 mi) from the impact area on its eastern end. If a fire started in the impact area, it would have to move east through low and very low fire risk areas, up low flammability cliffs, through the West Makaleha Management Unit, before reaching this unit. However, the loss of this critical habitat, in combination with the 382 ha (945 ac) of habitat outside the Makua action area, would remove its ability to provide for the conservation of four populations of *Hedyotis parvula*. One ha (2.4 ac) or 20 percent of the critical habitat in the action area is found within the Central and East Makaleha Management Unit. A small amount of critical habitat (less than 1 ha; 2.5 ac) is within the West Makaleha Management Unit. Approximately 80 percent of the critical habitat unit in the action area is not within a management unit. However, the fire risk to critical habitat in these management units and the critical habitat immediately adjacent to them is decreased due to the surrounding mesic forest vegetation which is of low flammability (Beavers et al 1999). This entire critical habitat unit is in an area of low and very low fire risk and is bordered by low and very low fire risk areas and management units. Fuel modification will occur within Central and East Makaleha Management Unit due to the control of alien plant species, some of which are highly flammable. In addition, the Central and East Makaleha Management Unit and the West Makaleha Management Unit will eventually be fenced, and non-native plant species will be controlled pursuant to the guidelines of the Makua Implementation Plan. The removal of ungulates and non-native invasive plant species within these management units enhances the conservation value of the critical habitat unit. The critical habitat outside of the management unit is separated from the impact area by other management units and low to very low fire risk areas. The fuel modification activities,

plus other conservation measures implemented by the Army for species stabilization, will further reduce the risk of fire to the portion of the critical habitat outside of the management units.
To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of this critical habitat unit (in conjunction with the portion that is outside the Makua action area) during the revegetation process, the ability of this unit to provide habitat essential for the conservation of four populations of *Hedyotis parvula* will be retained in the long-term.

Conclusion

The critical habitat unit for *Hedyotis parvula* in the Makua action area is located entirely within the low and very low fire risk areas. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire to the critical habitat will be reduced due to fuel reduction within adjacent management units. The portion of critical habitat that is within Central and East Makaleha, and the West Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *H. parvula* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *H. parvula* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *H. parvula.*

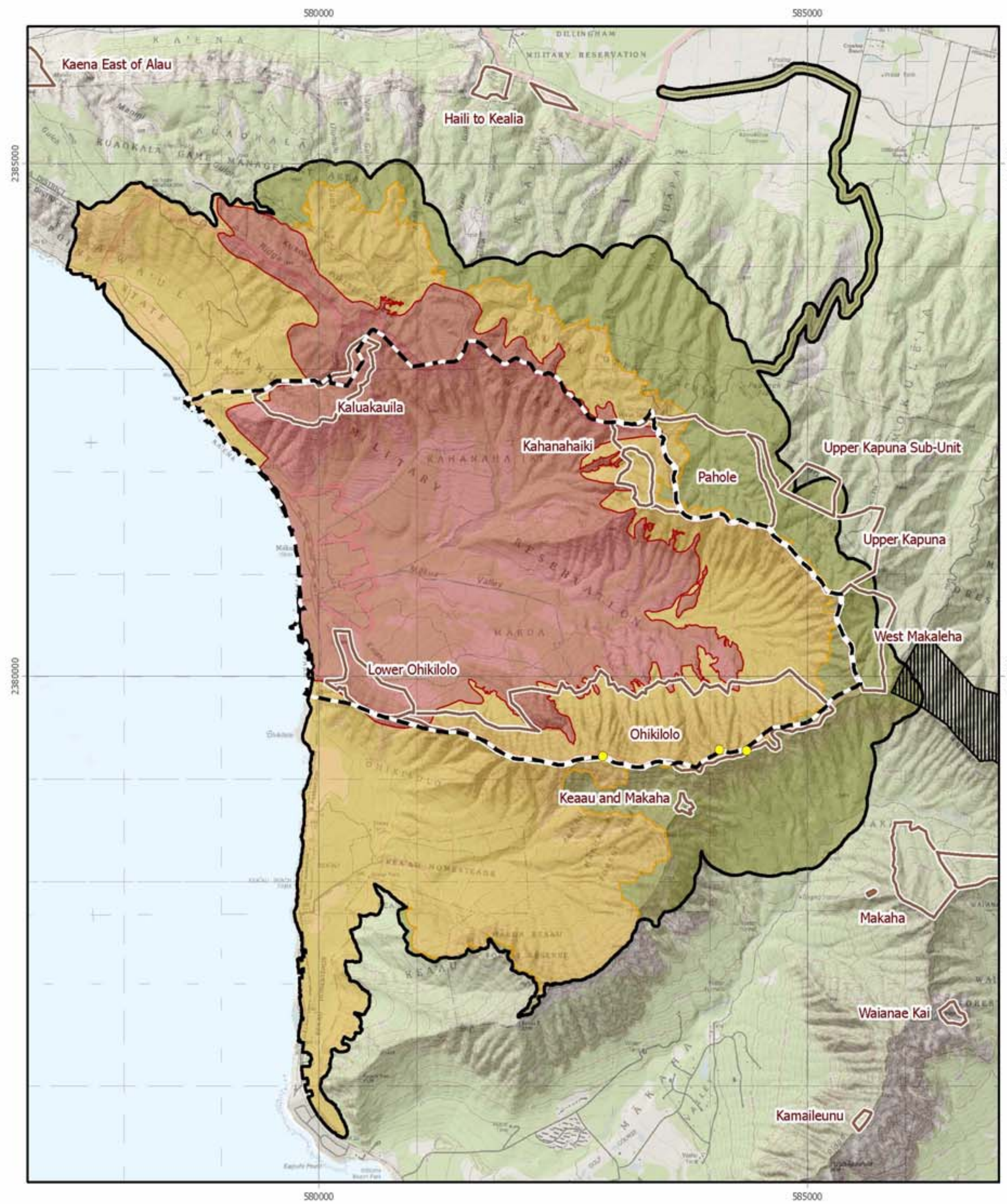


Figure E 20
Hedyotis parvula

- Species observation
- Critical habitat

- High Fire Risk Zone
- Low Fire Risk Zone
- Very Low Fire Risk Zone
- Management Units
- Makua Action Area
- Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Hesperomannia arbuscula* (No Common Name)

There is only one individual of *Hesperomannia arbuscula* remaining in the action area (Upper Kapuna Management Unit; see Figure E 21). There are 25 mature individuals of *H. arbuscula* on Oahu and only 90 individuals range-wide. Due to the extremely low numbers of *H. arbuscula*, there is a high background risk of extinction for this species. Some would argue this species is quasi-extinct due to its low numbers, inbreeding depression and high susceptibility to stochastic events. The science of conservation biology has documented a general pattern of population collapse for a wide range of plant and animal species (Dennis et al 1991; Schemske et al 1994; Morris et al 1999; Menges 2000) when the total number of reproductive individuals falls bellow a minimal threshold. The Army is managing this species as a stabilization species due to its limited abundance and restricted distribution. This lone plant is exposed to additional threats as described and analyzed in the General Effects section.

Species Response to the Proposed Action

The only individual of *Hesperomannia arbuscula* in the action area occurs in the very low fire risk zone. The risk of this one individual impacted by a training related wildland fire is very remote due to the mesic condition of its surrounding habitat and the distance from the impact area. The risk to extirpation for this species is greater due to other threats such as ungulate herbivory, non-native pests, lack of pollinators, or a demographic accident.

The data suggest this species is not self-sustaining and the number of individuals on Oahu has declined from approximately 40 individuals in 2003 to 25 in 2006 (see Status/Baseline). There is a small number of naturally occurring mature individuals (not managed) outside of the action area. The number of mature versus immature plants suggests there is not much natural recruitment. This species is not easily cross-pollinated and is susceptible to invertebrate pests like the black twig borer. As part of it efforts to manage this species for stability the Army will be establishing three populations units of 75 individuals each; one inside the action area (Upper Kapuna) and two outside the action area (North Palawi and Waianae Kai). The Army's efforts towards stabilization for this species include controlling threats to the species (feral ungulate control and the removal of exotic plants that compete with this species). According to the Makua Implementation Plan Addendum the Upper Kapuna Management Unit is scheduled to be fenced in 2007 thus removing the threat of predation by feral ungulates.

Conclusion

Hesperomannia arbuscula may already be in a phase of quasi-extinction, with numbers that have declined to the point where demographic stochasticity alone can result in extirpation from the wild. Thus, *H. arbuscula* has a very high background risk of species extinction, and any additional threats could eliminate expectation of its long-term persistence. This species will benefit from the stabilization criteria as outlined in the Makua Implementation Plan and the Makua Implementation Plan Addendum. There will be three occurrences of *H. arbuscula* with 75 mature reproducing individuals maintained over the long-term, including one inside the action area and two outside the action area to reduce the vulnerability of this specie to fire. Overall, the work conducted by the Army Natural Resources Staff will help protect this species from extirpation in Makua and improve its likelihood of persistence with minimal risk of loss due to a training-related wildland fire. Therefore, based on our analysis of the effects of the actions outlined in the Project Description, including training-related fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of Action on *Hesperomannia arbuscula* Critical Habitat

Critical habitat for *Hesperomannia arbuscula* within the Makua action area includes 213 ha (527 ac) or about 12 percent of the designated critical habitat for this species (see Figure E 21). It is located in the northeastern portion of the action area and is almost entirely in the low fire risk zones, with 17.8 ha (44 ac) in the low fire risk area and 195.2 ha (482.3 ac) in the very low fire risk area. A portion of the critical habitat unit, 288 ha (709 ac), is outside of the action area. The entire unit was designated to provide habitat for the conservation of two populations, each of 100 mature, reproducing individuals of *H. arbuscula* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, slopes or ridges in dry to wet forest dominated by *Acacia koa* (koa) or *Metrosideros polymorpha* (ohia). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within dry to wet forest dominated by koa or ohia. It is estimated that more than 60 percent of the critical habitat is located in forest with more than 50 percent native vegetation (U.S. Army Garrison 2003b; K. Kawelo pers. comm. 2004; 68 FR 35950; 68 FR 35950). This indicates that non-native plants are encroaching in this critical habitat unit. In the absence of habitat management, fires or continued non-native plant encroachment will add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

Eighty-two percent (253 ha; 625 ac) of the critical habitat unit is located in several management units (Pahole, West Makaleha, Central and East Makaleha, and Upper Kapuna). Due to the location of the critical habitat unit for *Hesperomannia arbuscula* and the similarities of the beneficial and negative impacts, please see *Schiedea obovata* for a more detailed effects analysis. The remaining critical habitat for *H. arbuscula* outside of all management units is approximately 56 ha (138 ac) and this area will be buffered from the impact area by the management units themselves. The fuel modification activities and the other threat reduction measures implemented by the Army for species stabilization will further reduce the risk of fire to all critical habitat inside and outside of the management units.

Conclusion

The critical habitat unit for *Hesperomannia arbuscula* in the Makua action area is located almost entirely in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire to the critical habitat located in the Pahole Management Unit will be reduced due to the construction of a fuel modification zone between the impact area and the adjacent Kahanahaiki Management Unit. In addition, fuel reduction within the management units will further buffer the critical habitat unit from fire. The critical habitat that is within the Central and East Makaleha, Kahanahaiki, Upper Kapuna Sub-unit, Pahole, Upper Kapuna, and West Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *H. arbuscula* critical habitat in the evaluation of the affect of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *H. arbuscula* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *H. arbuscula*.

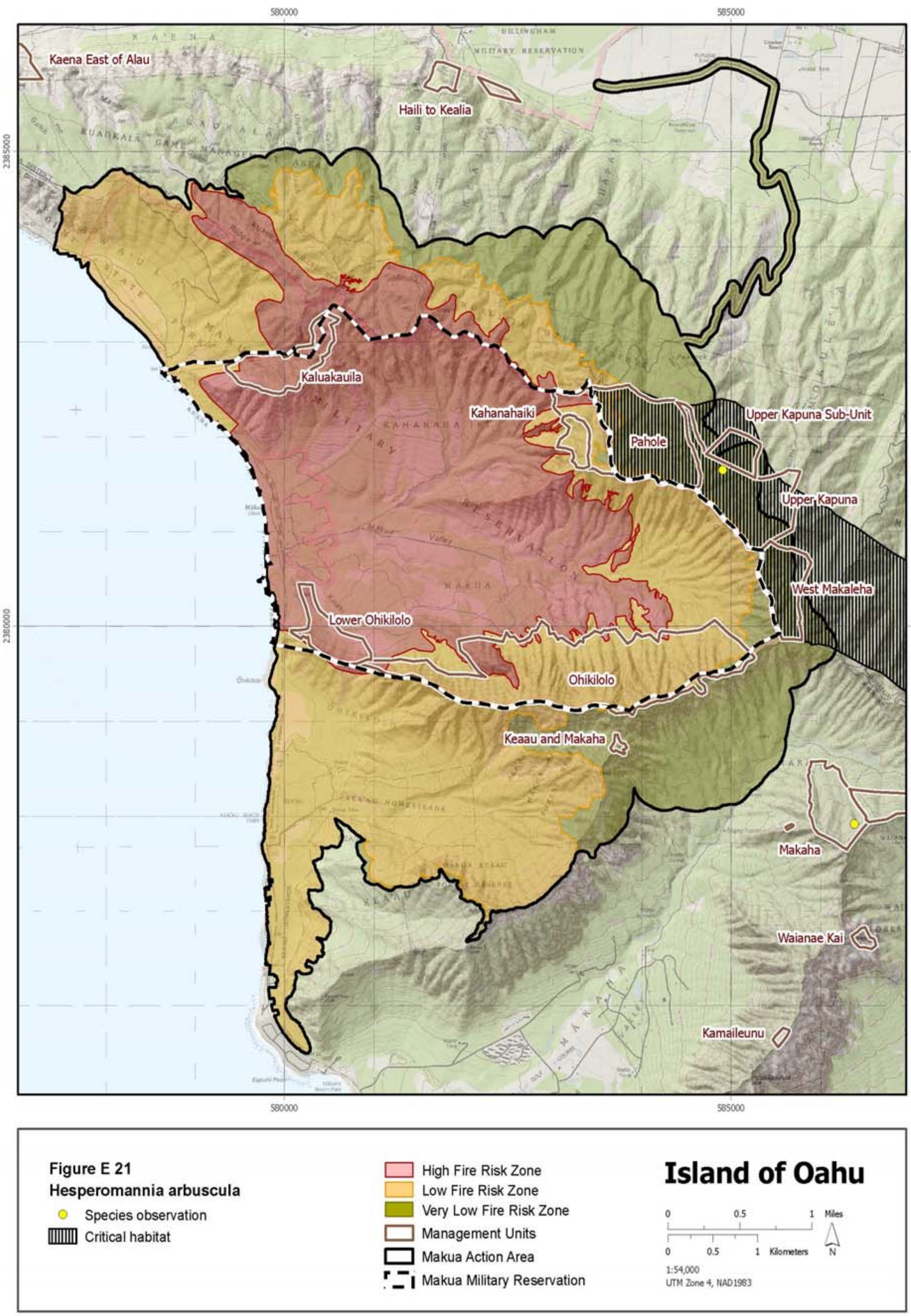


Figure E 21
Hesperomannia arbuscula

EFFECTS OF THE ACTION – *Melanthera tenuifolia* (Nehe)

Approximately 3,254 individuals of *Melanthera tenuifolia* (formerly *Lipochaeta tenuifolia*) occur in seven population units in the Waianae Mountains on Oahu. Approximately 50 percent (1,611 plants) grow within the Makua action area (Figure E 22). Four population units appear to meet numerical criteria for stabilization actions, but genetic differentiation among individuals of these vegetative-reproducing plants is unknown. *M. tenuifolia* appears to be returning to habitat where it had been extirpated by goats (U.S. Army Garrison 2005b). This species has a high background risk of extinction due to its very low numbers and lack of recruitment due to ungulate impacts. The Army is managing this species as a stabilization species pursuant to the Makua Implementation Plan Addendum.

<u>Species Response to the Proposed Action</u>

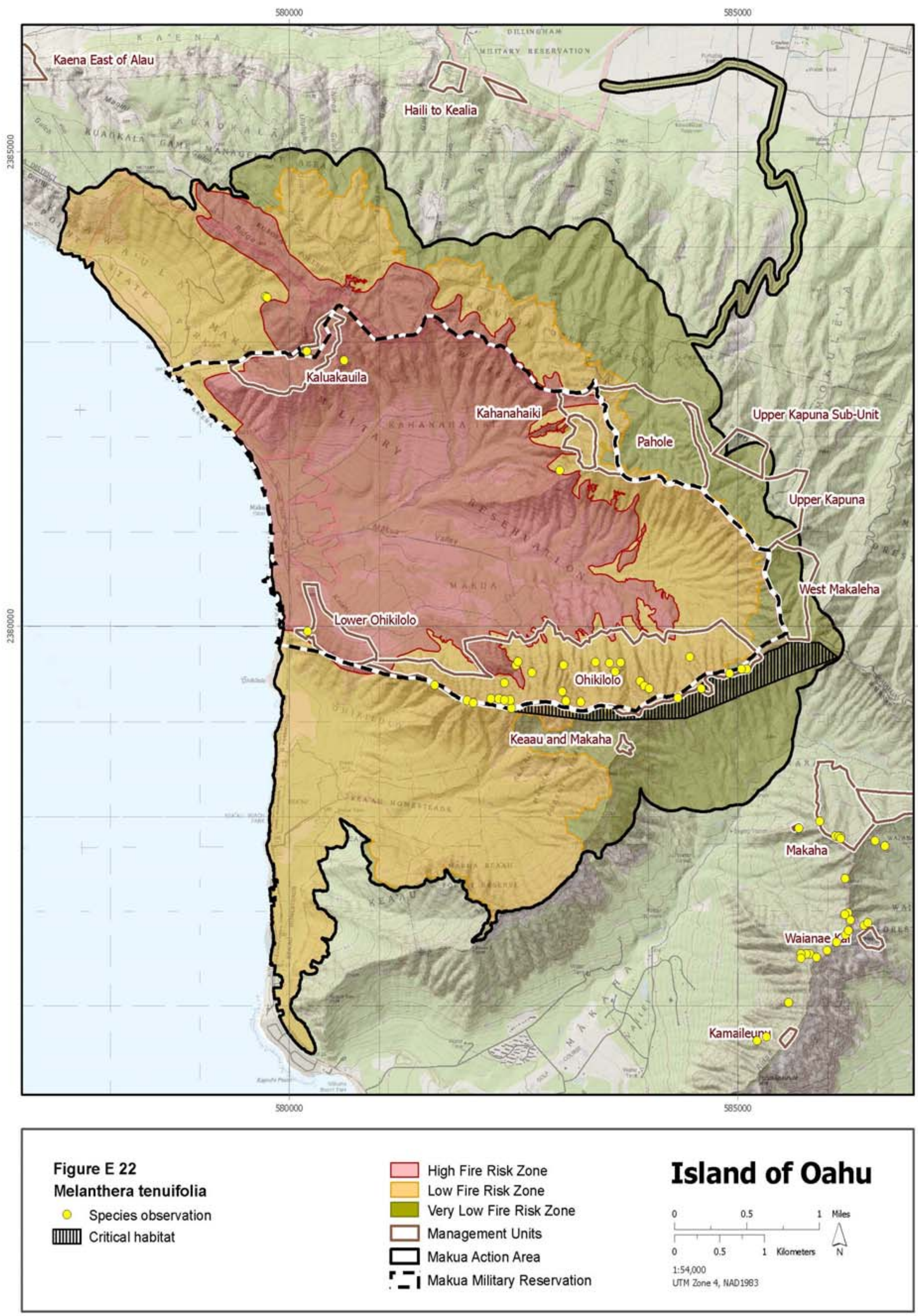
Wildland fires occurring because of Army actions at Makua are likely to lead to injury and death of *Melanthera tenuifolia* plants. An estimated 227 *M. tenuifolia* individuals are located in the high fire risk zone in the action area. Of these, 124 individuals grow in the Kaluakauila Management Unit where the 20-m (66-ft) wide forest edge fuelbreak with an integrated firebreak, and high priority fire suppression response, will minimize the risk of fire in this area. Fire risk to these plants, and four additional plants in the Punapohaku area below the Kaluakauila Management Unit, will be reduced further if the proposed fuelbreak running along the north lobe of the firebreak road is completed (see General Effects - Section 3.1.4.2). The *M. tenuifolia* individuals on the south side of Makua (11 in Lower Ohikilolo Management Unit and 88 in the lower grass slopes of Ohikilolo Management Unit) grow on sites in the high fire risk zone which are likely to be burned in fires associated with the proposed action. Eventually, fire protection to these management units, which will be implemented to achieve full stabilization, will abate the fire threat to these plants.

Approximately 42 percent (1,384 individuals) of *Melanthera tenuifolia* plants grow in the low fire risk zon (see Figure E 22). The 60 plants in the Keawaula population unit growing on the slopes north of Kaluakauila and the 1,243 plants growing on the upper cliff areas of Ohikilolo ridge are unlikely to be burned as a result of training-related fires due to the distance from the impact area and fire suppression response. An additional 81 plants, although located in the low fire risk zone (forest vegetation below the Kahanahaiki Management Unit) may be at a slightly higher risk of impact due to fire. These plants are only 20 m (66 ft) from the 2003 burn perimeter where the more flammable grasses have invaded the post-burn area (J. Rohrer, Army Natural Resources, pers. comm. 2007) thus making this area more susceptible to future fires.

The potential loss of *Melanthera tenuifolia* individuals due to Army-caused fires will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Army Natural Resources Staff will maintain three populations of 50 *M. tenuifolia*. The proposed Makaha fence will protect approximately 63 mature individuals from ungulates. Army Natural Resources Staff have met genetic storage goals for 21 *M. tenuifolia* individuals; complete genetic storage goals are expected to be met for this species. The Army currently maintains living collections from 64 individuals and has stored more than 10 seeds from 35 founders (U.S. Army 2006). The Army is conducting seed storage research to determine the most effective genetic storage techniques for this endangered species. Two wildland fires, ignited by the public adjacent to Farrington Highway in 2006, are believed to have burned additional individuals of *M. tenuifolia* in the Lower Ohikilolo Management Unit and on the slopes north of Kaluakauila Management Unit (U.S. Army Garrison 2006c). The Waianae Kai population unit is exposed to fires ignited in the grassy Waianae Valley. Fire suppression helicopter assistance, provided by the Army on State and City and County wildland fires will minimize fire impacts to this species and fuel treatments in the vicinity of management units will reduce the fire risk to plants inside and outside the action area.

Conclusion

Approximately 1,611 *Melanthera tenuifolia* plants (50 percent of known individuals of this species) grow within the Makua Action Area. A total of 103 *M. tenuifolia* grow in sites in the high fire risk zone where they are likely to burn unless additional fuel treatments are implemented. An additional 124 individuals are situated in the high fire risk zone within the Kaluakauila Management Unit where fire risk will be minimized by new fuelbreaks and high priority allocation of fire suppression resources and 1,384 plants grow in the low fire risk zone where the likelihood of an unsuppressed wildland fire is minimal. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning many of these *M. tenuifolia* plants. The potential damage or loss of *M. tenuifolia* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Fencing and ungulate control are expected to result in increases in numbers and vigor of *in situ* plants. The Army's genetic storage efforts will ensure the genetic variability of this endangered species is preserved. The overall effect of the proposed action's stressors and subsidies will result in a net increase in the numbers, distribution, and reproductive success of *M. tenuifolia* in and adjacent to the action area over the next 30 years. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.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Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 22
Melanthera tenuifolia
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
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Management Units
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Makua Military Reservation
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EFFECTS OF THE ACTION – *Nototrichium humile* (Kului)

Sixty eight percent (858 out of a total of 1,256) of all *Nototrichium humile* occur within the Makua action area. There are seven population units of this species growing inside the Makua action area and nine population units outside the action area, elsewhere in the Waianae Mountains (Figure E 23). An additional occurrence was documented on Maui in 1979 (68 FR 25934), but the status of this population has not been updated since then. The July 2003 escaped prescribed fire at Makua burned 2.4 ha (6 ac) of *N. humile* critical habitat on State land north of the Kaluakauila Management Unit and killed five plants in the Punapohaku population unit (U.S. Army 2003b). At the time of the 2003 fire, only 11 plants were thought to occur on this slope; more extensive surveys, conducted in August 2003, resulted in an updated estimate of 173 plants in the Punapohaku population unit (K. Kawelo, pers. comm. 2007). This species has a high background risk of extinction due to its occurrence in dry fire-prone areas. The Army is managing this species as a stabilization species pursuant to the Makua Implementation Plan Addendum because of its limited abundance and restricted distribution. Plant numbers already meet numerical criteria for stabilization in three out of the four population units targeted for stabilization management (U.S. Army 2006c).

<u>Analysis of Effects of the Proposed Action</u>

There are 590 *Nototrichium humile* plants (47 percent of all known individuals) growing in the high fire risk zone, 267 individuals (21 percent) in the low fire risk zone, and one plant in the very low fire risk zone in the Makua action area. New weapons restrictions, improved grass mowing around the interior of the south lobe of the firebreak road, and increased fire suppression staffing requirements minimize the risk that a fire will escape containment by initial attack fire suppression resources, particularly prior to implementation of Column C weapons restrictions.

High Fire Risk Zone: In the event that a large fire threatens the 283 plants in the Kaluakauila Management Unit, the 20-m (66-ft) wide fuelbreak running along the forest edge, with its imbedded firebreak, will provide suppression resources, including red-carded Army Natural Resources Staff and fire suppression helicopters, a high likelihood of successfully preventing fires from burning forested areas within the management unit. Four recent fires that escaped initial attack at Makua (1970, 1984, 1995, and 2003) burned the slopes and edges of the forested areas where the 323 plants in the Punapohaku population unit occur. Fewer than 90 *Nototrichium humile* were found burned by the 1995 escaped prescribed burn (U.S. Army 1995) and five were burned by the 2003 escaped prescribed burn (U.S. Army 2003) in this area. Prior to implementation of Column C weapons restrictions, or within the next five years, one of several alternative measures will be instituted to further minimize the risk of fire impacts to the *N. humile* in the Punapohaku population unit (see Project Description section 3.1.4.2).

The Army will be establishing a 40-m (131 ft) wide fuelbreak to reduce the high risk of fire to the 25 *Nototrichium humile* plants growing on the slopes below the Kahanahaiki Management Unit. Plants growing on cliffs, or protected by Kukui drainages, are unlikely to be burned. GIS analysis indicates that most of the plants grow less than 50 m (164 ft) from continuous grass fuels, where they may be impacted by fires burning around or spotting across the fuelbreak. Some of these plants are located south of the fuelbreak location, where their fire risk will not be reduced by the fuel treatment.

Nine *Nototrichium humile* plants grow on a cliff directly below a grassy south aspect slope in Kahanahaiki Gulch that has repeatedly burned in the historic escaped fires at Makua (Hawaii Department of Land and Natural Resources 1970, U.S. Army fire reports 1995 and 2003). If a fire does burn into the Kahanahaiki Management Unit in Kahanahaiki Gulch, the site where the plants occur will be inaccessible to the firefighters staffing the area. The Army is establishing a firebreak or fuelbreak along the perimeter of the Kahanahaiki Management Unit (see Project Description section 3.1.4.1) to minimize the fire risk in Kahanahaiki Gulch. GIS analysis indicates that these fire risk minimization measures will leave approximately 34 *N. humile* at a high risk of burning in fires associated with Army live-fire training.

A total of 267 *Nototrichium humile* individuals (21 percent of the total rangewide individuals) grow in the low fire risk zone (73 in the Ohikilolo Management Unit, 51 plants in the Keaau population unit, and 143 in the Keawaula population unit). Fifty one of the individuals in the Ohikilolo Management Unit grow in the vegetated slopes below the cliff areas, and 22 plants grow high on the cliffs in this area. Fifty one additional *N. humile* plants are in the Keaau population unit, 1,000 m (3,281 ft) south of Ohikilolo Management Unit. The 51 plants growing in the shrub and forest vegetation below the cliffs in Ohikilolo, and the 51 plants growing in the Keaau population unit may be burned by a fire escaping initial attack containment efforts (see General Effects – Fire Suppression). All 124 of the plants in the low fire risk zone may also be impacted by a fire ignited by a misfired long-range, live-fire weapon such as the TOW, and a spot fire resulting from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression).

The 143 *Nototrichium humile* plants in the Keawaula population unit occur in a small shrubby gulch on a grassy slope north of the Kaluakauila Management Unit, approximately 50 m (164 ft) from areas burned in previous Army fires escaping containment by initial attack resources (Hawaii Department of Land and Natural Resources 1970 and 1984). A large fire ignited on State land near Farrington Highway burned through this area in 2006 (Hawaii Department of Land and Natural Resources 2006) but impacts to the *N. humile* have not been ascertained. Prior to implementation of Column C weapons restrictions, or within the next five years, one of several alternative measures will be instituted to further minimize the risk of fire impacts to the *N. humile* in this area (see Project Description section 3.1.4.2).

One *Nototrichium humile* individual in the Keaau population unit, south of Ohikilolo Ridge grows in the very low fire risk zone. This plant could be burned by a misfired long-range, live-fire weapon such as the TOW, or a spot fire resulting from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression).

Nototrichium humile will be stabilized pursuant to the Makua Implementation Plan Addendum. Army stabilization actions will result in threat control for 25 reproducing individuals in four population units and genetic storage for this species. Three stabilization population units currently exceed these numerical criteria for stabilization and 16 out of the necessary 25 mature reproducing individuals already occur in Makaha, the fourth managed population unit. Natural recruitment is expected to increase when the Army completes fencing and ungulate removal in the Waianae Kai Management Unit. Ungulate removal in Kaluakauila Management Unit resulted in increased recruitment of *N. humile* (K. Kawelo, pers. comm. 2007) and therefore natural recruitment is expected to increase from the Army's fencing and ungulate removal in Makua Valley (scheduled for completion within five years) and the Waianae Kai Management Unit (scheduled for 2011 completion). Army fire suppression helicopter assistance to State and City and County fire suppression efforts outside the action area (for instance Kaimuhole and Palikea Gulch, Makaha, and Waianae Kai population units) will minimize the likelihood that the 313 plants (24 percent of all known individuals) growing in these population units will be burned. The fire threat to a minimum of 25 individuals in each of the four manage for stability population units will also be minimized, in most cases, by clearing grass from within 3 to 5 m (10 to 16 ft) of each plant (S. Ching, pers. comm. 2007). Future management unit level fire protection will provide long-term protection to these plants, as well as the other individuals occurring within all of the management units.

The Army's genetic storage efforts will ensure that genetic materials from approximately 153 genotypes from plants at high risk from fires occurring outside the action area (Kaimuhole and Palikea Gulch (50 founders), Keawapilau (5 founders), Kolekole (12 founders), Makaha (19 founders), Nanakuli (5 founders), Puu Kaua (12 founders), and Waianae Kai (50 founders) will be maintained (U.S. Army 2006c)). Problems with seed collection and low germination rates in the lab (1 out of 50 seeds germinate) have limited successful seed storage. Sixty two founders are currently maintained as cuttings in an Army plant propagation facility (U.S. Army 2006c).

Conclusion

Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *Nototrichium humile* in the action area. The potential damage or loss of *N. humile* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Fencing and ungulate control, weed control, and genetic storage are expected to increase numbers of *N. humile*. Army fire suppression helicopter assistance to State and City and County fire suppression efforts outside the action area will minimize the likelihood that the plants growing in these areas will be burned. Future management unit level fire protection will provide long-term protection to the *N. humile* occurring within all management units. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Nototrichium humile* Critical Habitat

There are two critical habitat units within the Makua action area represented by units A and B for *Nototrichium humile* (see Figure E 23). These two units represent approximately one percent (6 ha; 16 ac) of the total State-wide critical habitat for this species. Critical habitat unit A is located in the northwestern portion of the action area in a high fire risk area. This unit was designated to provide habitat necessary for the conservation of one population of *N. humile*. Critical habitat unit B is located in the very low fire risk zone with 1.33 ha (3.28 ac) in the northeastern portion of the action area. This unit will provide habitat necessary for the conservation of a portion of two populations of *N. humile*. At least 300 mature, reproducing individuals of *N. humile* will comprise each population (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, cliff faces, gulches, stream banks or steep slopes in dry or mesic forests often dominated by *Diospyros sandwicensis* (lama) or *Sapindus oahuensis* (lonomea). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within dry or mesic forests often dominated by lama or lonomea. It is estimated that 79 percent of the critical habitat is in areas with less than 50 percent native plant cover (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that these critical habitat units are currently degraded due to non-native plant encroachment. Although degraded, both units still support individuals of *N. humile* and provide habitat that is necessary for the expansion of these populations in order to contribute to the recovery goals for this species.

Portions of critical habitat unit A have been impacted by past fire events, which further diminishes the conservation value of this habitat. Fire removes the vegetative primary constituent elements, and natural recruitment is precluded by the influx of invasive non-native plants. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of these critical habitat units by removing the remaining vegetative primary constituent elements.

Critical habitat unit A is approximately 6 ha (16 ac), of which 4 ha (11 ac) are in the Kaluakauila Management Unit within the high fire risk area. Due to the close proximity of this unit to the fire source, there is a risk that a fire started in the impact area could move north and impact this unit. The loss of vegetative primary constituent elements of this critical habitat unit would remove its ability to provide habitat for the conservation of one population of *Nototrichium humile*. See *Neraudia angulata* for a discussion of the effects of fire and management.

Critical habitat unit B is 1 ha (3 ac) and occurs in the low and very low fire risk area. This unit is part of a larger 230 ha (568 ac) critical habitat unit that extends outside the Makua action area. Unit B is approximately 1 km (0.6 mi) from the impact area along its western boundary and there is a risk, albeit slight, that a fire started in the impact area could move east over cliffs and across management units, where the Army is conducting fuel reduction actions, to impact this unit. However, the fire risk is decreased due to the surrounding mesic forest vegetation which is of low flammability and the buffer of surrounding management units, also of low flammability and managed to reduce non-native plants, and, therefore, fuel load (Beavers et al 1999). The loss of vegetative primary constituent elements within this unit would remove the ability of this unit to provide for the conservation of a portion of two populations of *Nototrichium humile*. See *Neraudia angulata* for a discussion of the effects of fire and management in the Upper Kapuna Sub-unit Management Unit and *Hedyotis parvula* for the West Makaleha Management Unit.

To reduce the impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the revegetation process, their ability to provide habitat essential for the conservation of three populations of *Nototrichium humile* will be retained in the long-term.

Conclusion

Over 99 percent of the critical habitat unit for *Nototrichium humile* in the Makua action area is located within the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced for critical habitat unit A due to the construction of a fuel modification zone between the impact area and Kaluakauila Management Unit. In addition, fuel reduction within the management unit will further buffer unit A from fire. Fuel reduction within the Upper Kapuna Sub-unit Management Unit will further buffer unit B from fire. The critical habitat within the Kaluakauila Management Unit and the portion of critical habitat in unit B that is within Upper Kapuna Sub-unit and West Makaleha management units will be managed to improve their baseline quality, pursuant to the Makua Implementation Plan. Without this management, these critical habitat units would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *N. humile* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *N. humile* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *N. humile*.

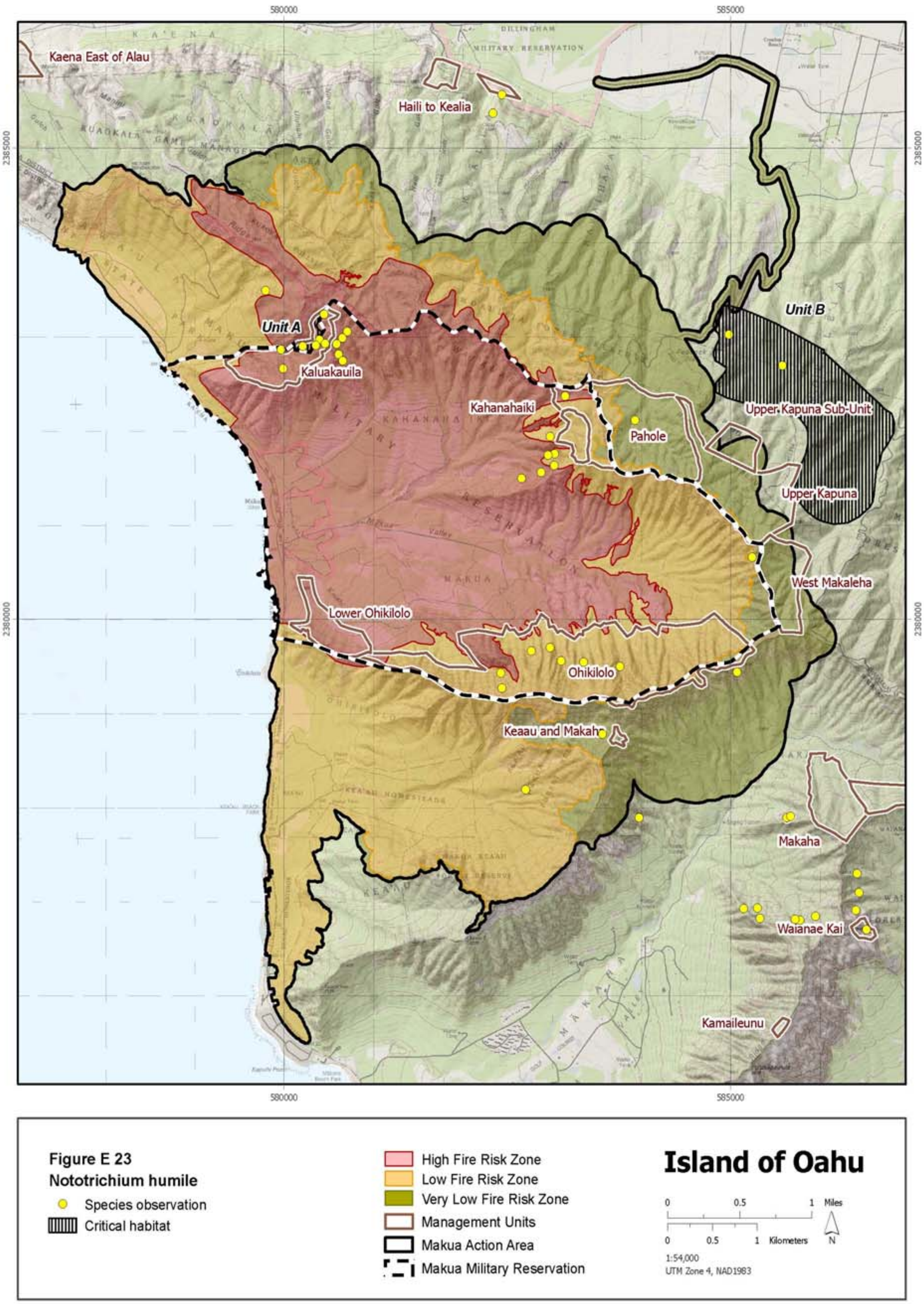


Figure E 23
Nototrichium humile

EFFECTS OF THE ACTION – *Plantago princeps* var. *princeps* (Ale, Laukahikuahiwi)

Approximately 42 *Plantago princeps* var. *princeps* shrubs (12 percent of all Oahu individuals) grow in the action area, in the Ohikilolo and Pahole Management Units (Figure E 24). A total of 354 *P. princeps* var. *princeps* grow in nine population units on Oahu and an additional 490 to 1,962 plants (of four varieties) occur on other Hawaiian Islands (U.S. Army Garrison 2005b). Recent ungulate removal at the Ekahanui population unit resulted in increased natural recruitment of *P. princeps* var. *princeps* at this site (D. Sailer, Army Natural Resources, pers. comm. 2007). Rat herbivory to this fleshy plant is a problem in the North Palawai and Kahanui population units in Honouliuli Preserve and may have caused the near disappearance of the North Palawai population units (U.S. Army Garrison 2005b). This plant is at a high risk of extirpation from Oahu due to ungulate and rat impacts and other ecosystem-wide threats (see General Effects). The Army is managing this species as a stabilization species pursuant to the Makua Implementation Plan Addendum because of its limited abundance and restricted distribution.

<u>Species Response to the Proposed Action</u>

The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Plantago princeps* var. *princeps* individuals in the action area. Sixteen *P. princeps* var. *princeps* individuals growing in the low fire risk zone in the Pahole Management Unit and 26 individuals grow in the very low fire risk zone in the Ohikilolo Management Unit within the Makua action area. By maintaining 200 m (656 ft) of shrub vegetation between the grass-dominated areas in Makua Valley and the Pahole Management Unit (see Project Description section 3.1.3), the Army minimized the risk that a fire will spread from the valley into the management unit (see General Effect – Fire Suppression). All 42 plants in the action area are at risk of being burned in a fire ignited by a misfired long-range, live-fire weapon such as the TOW, and spot fires resulting from an intense grass fire in the Makua Valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects).

Stabilization actions proposed by the Army, including outplanting, ungulate and rat control, Army wildland fire suppression assistance, and genetic storage, are likely to result in increased probability that this species will persist on Oahu. By assisting the City and County of Honolulu with the protection of Honouliuli Preserve from wildland fire, the Army will ensure the maintenance of the largest population of this species on Oahu. By constructing the Palikea and Ekahanui fences and removing ungulates from these areas, increased vigor and recruitment of *Plantago princeps* var. *princeps* plants. The Army has successfully propagated this species in greenhouses and the National Park Service has successfully outplanted *Plantago princeps* var. *laxiflora* on Maui (U.S. Army Garrison 2006c). Therefore, augmentations proposed to increase the number of mature, successfully reproducing individuals growing in four population units in threat-controlled areas to 50 are expected to be successful.

Conclusion

Despite the ongoing exposure of *Plantago princeps* var. *princeps* to wildland fire impacts associated with the proposed project, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fire detection and fire suppression helicopter staffing and maintenance of the 200-m (656-ft) wide shaded fuelbreak adjacent to Pahole Management Unit will minimize the risk of training-related wildland fire to the *P. princeps* var. *princeps.* Ungulate and rodent control, ecosystem management, and genetic storage activities conducted by the Army over the next 30 years will increase population numbers of *P. princeps* var. *princeps* in four population units, including three outside the action area that will not be exposed to training-related wildland fire. Therefore, based on our analysis of the effects of the actions outlined in the Project Description, including training-related fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Plantago princeps* var. *princeps* Critical Habitat

There are two critical habitat units in the Makua action area for *Plantago princeps* var. *princeps* that represent only two percent (62 ha; 153 ac) of the total critical habitat designated for this species (see Figure E 24). Located in the northeastern portion of the action area, all critical habitat is within the two low fire risk zones with 3.4 ha (8.3 ac) in the low fire risk area and 58.3 ha (144.2 ac) in the very low fire risk area. Critical habitat unit A (15 ha; 37 ac) was designated, in combination with critical habitat unit B, to provide habitat for the conservation of one population of at least 300 mature, reproducing individuals of *P. princeps* var. *princeps*(68 FR 35950). Critical habitat unit B is part of a larger 53 ha (130 ac) critical habitat unit that extends outside the Makua action area. The primary constituent elements essential for this species include, but are not limited to, slopes or ledges in *Metrosideros polymorpha* (ohia) lowland mesic forest or shrubland (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within an ohia lowland mesic forest or shrubland community on Oahu. It is estimated that the majority of the critical habitat is in areas comprised of greater than 50 percent native plant cover, indicating that there has been some habitat degradation in these units. Portions of this critical habitat may have been impacted by past fire events, which diminishes the conservation value of the habitat by removing the vegetative primary constituent elements. Non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

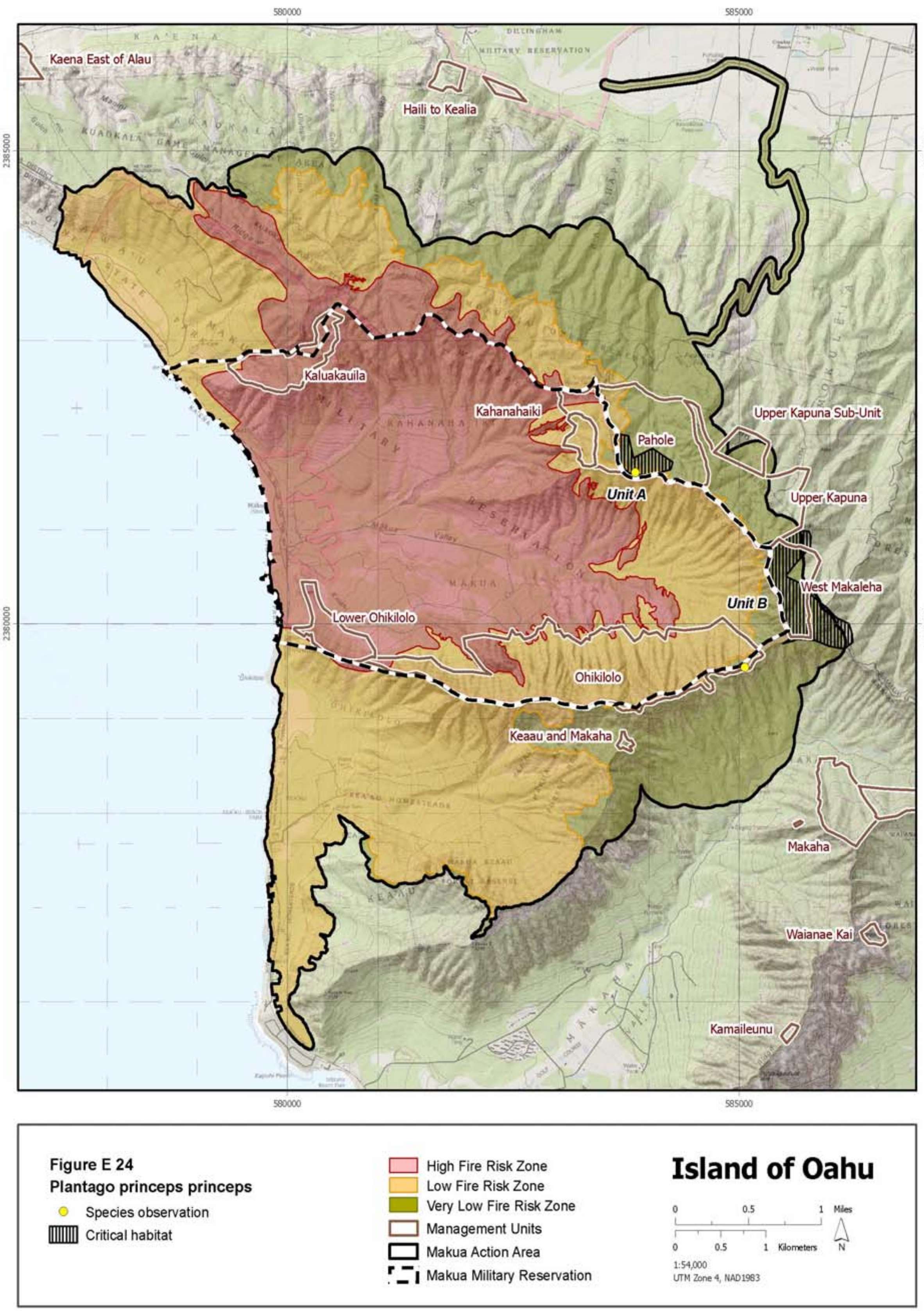
The western boundaries of critical habitat units A and B are approximately 0.2 km (0.1 mi) and 1 km (0.6 mi), respectively, from the fire source and there is a risk that a fire started in the impact area could move east and impact these units. The loss of vegetative primary constituent elements within these two units would remove their ability to provide for the conservation of a portion of one population of *Plantago princeps* var. *princeps*. Most of the western edges of the two critical habitat units are immediately adjacent to low and very low fire risk areas. Approximately 72 percent (35 ha; 86 ac) of the critical habitat in the action area is found within management units (Pahole, Upper Kapuna, West Makaleha, Central and East Makaleha, and Kahanahaiki). To reduce the risk of fire to listed species and their habitat, the Army is preparing wildland fire management plans for the Kahanahaiki and Ohikilolo management units. Implementation of these plans will reduce the risk of fire to *P. princeps* var. *princeps* critical habitat due to construction of fuel modification zones between the impact area and the Kahanahaiki Management Unit, adjacent to critical habitat unit A; and, between the impact area and the Ohikilolo Management Unit, adjacent to critical habitat unit B. Fuel modification will buffer the Kahanahaiki Management Unit from fires that spread outside the impact area and in turn buffer the critical habitat unit A in the adjacent Pahole Management Unit.

Implementation of the Ohikilolo fire management plan and fuel reduction actions, such as removal of non-native plants in the West, and East and Central Makaleha management units will reduce the risk of fire impacting portions of critical habitat unit B outside the management units. The Army is implementing other threat abatement measures in the management units, such as removal of non-native plants, to enhance the habitat in the management units. The Pahole and Kahanahaiki management units are fenced, and the Army has fenced portions of the West Makaleha Management Unit. Fences are planned for the Central and East Makaleha and Upper Kapuna management units, pursuant to the Makua Implementation Plan. Ungulates will be removed from these fenced areas. The Army is working to reduce non-native plants in all of these management units. The Army is conducting rat control in the Kahanahaiki and West Makaleha management units to reduce their impacts on listed and associated native plants. All of these conservation actions within the management units, pursuant to the Makua Implementation Plan, will enhance the conservation value of the two critical habitat units. Some actions, such as removal of non-native plants, decrease the risk of fire in part by reducing the fuel load in these management units. The portion of critical habitat unit B that is outside the management units (27 ha; 71 ac) is separated from the impact area by low and very low fire risk areas and by the Ohikilolo and West Makaleha management units. Spatial separation from the impact area, adjacent low and very low fire risk area along the western boundary of critical habitat unit B, fuel modification actions that will be implemented for the Ohikilolo Management Unit, and the aforementioned activities implemented by the Army for species stabilization in the West Makaleha Management Unit will further reduce the risk of fire to the portion of critical habitat outside management units.

To reduce the negative impacts to this critical habitat unit from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the function of the critical habitat units in the action area, in conjunction with the portion that extends outside the action area, the ability of these units to provide habitat essential for the conservation of four populations of *Plantago princeps* var. *princeps* will be retained in the long-term.

<u>Conclusion</u>

The two critical habitat units for *Plantago princeps* in the Makua action area are entirely within the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of fuel modification zones between the impact area and the Kahanahaiki and Ohikilolo management units. In addition, fuel reduction within the management units will further buffer the critical habitat units from fire. The portions of critical habitat within the Pahole, West, East and Central Makaleha, and Upper Kapuna management units will be managed to improve their baseline quality, pursuant to the Makua Implementation Plan. Without this management, these critical habitat units would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to these habitats (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *P. princeps* var. *princeps* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *P. princeps* var. *princeps* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *P. princeps* var. *princeps*.


Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Unit A
Upper Kapuna
West Makaleha
Unit B
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
580000
585000
2385000
2380000
Figure E 24
Plantago princeps princeps
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Pritchardia kaalae* (Loulu)

A total of 841 *Pritchardia kaalae* plants (92 percent of the 911 total range-wide individuals) grow in the Ohikilolo and West Makaleha population units in the action area (Figure E 25). *P. kaalae* is a palm tree, endemic to Oahu's Waianae Mountains. Three hundred fifty six (39 percent of all plants) *P. kaalae* occur as a result of Army propagation and outplanting efforts. Little natural recruitment has been observed where rat fruit predation and ungulate herbivory occur (U.S. Army Garrison 2006c). This species may also be vulnerable to lethal yellowing, a palm disease transmitted by a sap-sucking plant hopper, *Myndus crudus*, which is prevalent in many tropical and subtropical zones worldwide although it is not yet found in Hawaii (Murakami 1999). *Pritchardia kaalae* has a high background risk of extinction due to its very low numbers and lack of recruitment due to ungulate and rat threats. The Army is managing this species as a stabilization species pursuant to the Makua Implementation Plan Addendum because of its limited abundance and restricted distribution.

Species Response to the Proposed Action

The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Pritchardia kaalae* individuals in the action area. Approximately 75 mature and 694 immature *P. kaalae* plants grow in the low fire risk zone where they may be burned by an Army-caused fire and 72 immature individuals grow in the very low fire risk zone where fire is less likely to occur. Nine of the plants in the low fire risk zone grow on Ohikilolo Ridge, within approximately 50 m (164 ft) of previously burned grass slopes. The rest of the plants occur higher on the ridges of Makua Valley, where a fire could be ignited by a misfired long-range, live-fire weapon such as the TOW, and burn due to a spot fire from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent a fire ignited in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression). Fire resistance of this species is not documented, but seedlings of other palm species are often killed by fire, while mature palms often survive even high intensity fires (Abrahamson 1984a, Abrahamson 1984b, and Menges and Kohfeldt 1995). Army weapons restrictions, fire suppression staffing, and fuels management are designed to minimize the fire threat to the *P. kaalae* growing within the action area.

Pritchardia kaalae are particularly vulnerable to seedling predation by goats and pigs, and fruit predation by rats (Makua Implementation Team 2003, U.S. Army Garrison 2005b, U.S. Army Garrison 2006c). Substantial increases in seedling numbers have occurred in the Ohikololo population unit where rat control and fencing with ungulate removal have been completed by Army Natural Resources Staff. Only one germinating fruit and no seedlings were observed in the Ohikilolo population unit in 1999. Due to Army fencing, ungulate eradication, and rat control, the number of seedlings has increased from 221 in 2005 to 410 in 2006 (U.S. Army Garrison 2006c). The Makaha, Makaleha to Manuwai, and Waianae Kai population units will benefit from the Army's rat control efforts and ungulate removal, slated for completion at these sites by 2012. Genetic storage and habitat conservation actions proposed by the Army increase the likelihood that this species will persist.

Conclusion

Ninty-two percent of the 911 known *Pritchardia kaalae* occur in the action area and are located in the low and very low fire risk zones. Weapons restrictions, fire detection, fire suppression helicopter staffing, and implementation of suppression actions by skilled NWCG-qualified fireline supervisors will minimize the risk of a fire burning *P. kaalae* in the action area. The potential damage or loss of *P. kaalae* individuals from wildland fires associated with live-fire training will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Three hundred fifty six (39 percent of the total) *P. kaalae* occur as a result of Army propagation and outplanting efforts, and ungulate removal and rat control appear to have resulted in an increase in seedling numbers from zero (in 1999) to 410 (in 2006) in the Ohikilolo Population Unit (U.S. Army Garrison 2006c). Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

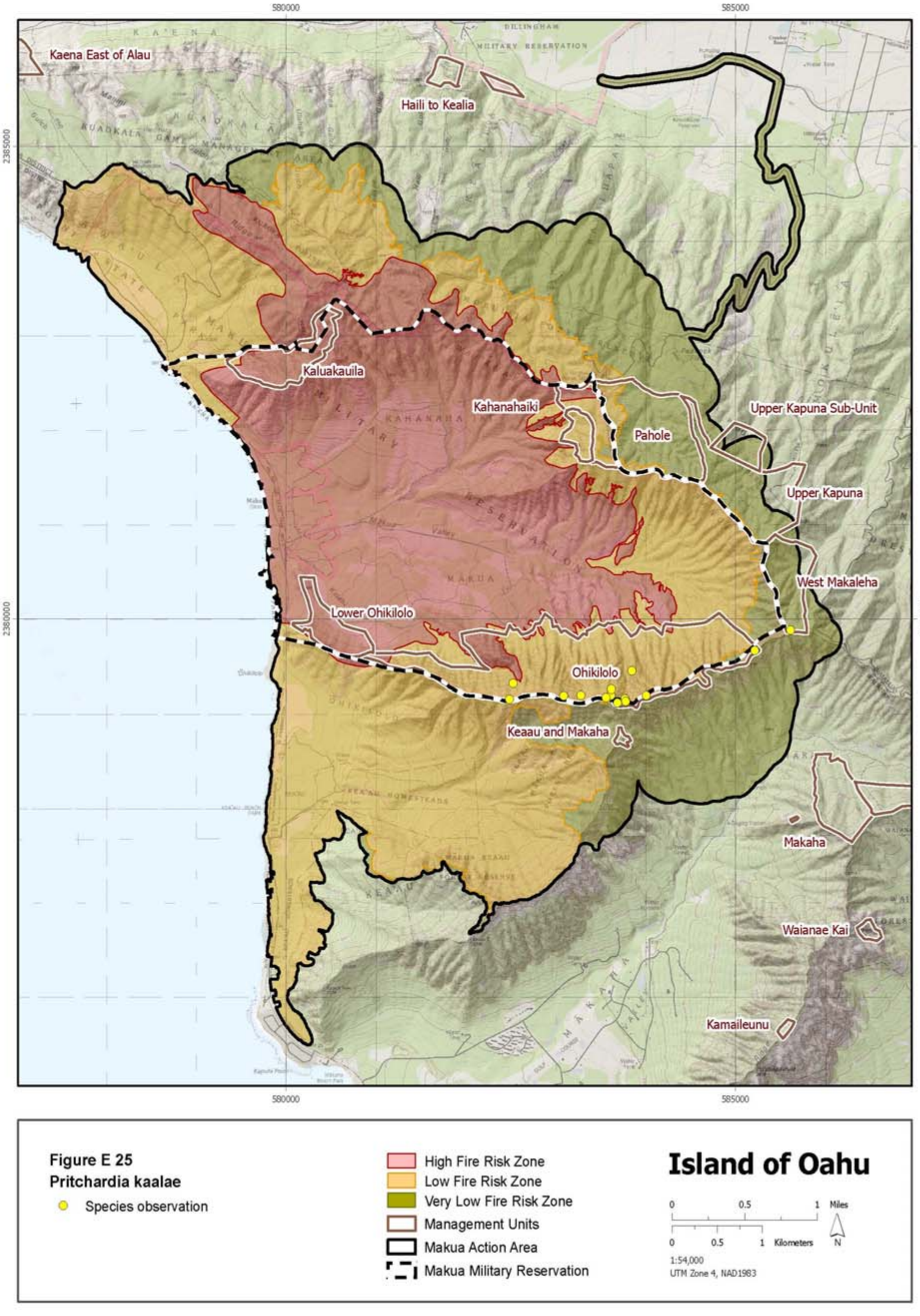


Figure E 25
Pritchardia kaalae

EFFECTS OF THE ACTION – *Schiedea kaalae* (No Common Name)

There are approximately 22 (three naturally occurring and 19 outplanted) *Schiedea kaalae* in the action area located in the Pahole Management Unit (Figure E 26). There are a total of 235 total individuals (43 naturally occurring, 192 outplanted) of this Oahu endemic species, located in 10 population units the Waianae and Koolau Mountains. One plant occurs in the Schofield Barracks West Range action area. Eighty one percent of *S. kaalae* plants exist because of propagation and outplanting efforts by the Army and The Nature Conservancy (U.S. Army Garrison 2005 and 2006c). *Schiedea kaalae* has a high background risk of extinction due to its very low numbers, low isozyme variability (Wagner et al 2005), and vulnerability to slug and snail herbivory (U.S. Army Garrison 2005b). The Army is managing this species as a stabilization species, pursuant to the Makua Implementation Plan Addendum, because of its limited abundance and restricted distribution.

Species Response to the Proposed Action

The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Schiedea kaalae* individuals in the action area. The three naturally occurring and 19 outplanted *S. kaalae* in the Pahole Management Unit grow in the very low fire risk zone of the action area where they may be burned in a fire ignited by misfired long-range, live-fire weapon such as the TOW, and a spot fire resulting from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent fires ignited in forested areas by misfired weapons from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression).

The potential damage to or loss of *Schiedea kaalae* individuals due to Army-caused fires will be offset by ongoing efforts by the Army to complete stabilization actions for this species. Stabilization will result in four population units of 50 reproducing individuals in areas where there are currently only 0, 3, 14, and 16 naturally occurring plants (U.S. Army Garrison 2006c). Army-funded slug control research may lead to techniques that will increase natural recruitment of this species. Ungulate removal and ecosystem scale weed control will also benefit this species. The Army has collected seeds from 19 founders in five population units and will complete and maintain genetic storage for all 42 wild individuals.

Conclusion

Weapons restrictions, fire detection, fire suppression helicopter staffing, and implementation of suppression actions by skilled NWCG-qualified fireline supervisors will minimize the risk of a fire burning *Schiedea kaalae* in the action area. The potential damage or loss of *S. kaalae* individuals from wildland fires associated with live-fire training will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Stabilization actions proposed by the Army, including augmentations, ungulate control, slug control research, and genetic storage, increase the probability that this species will persist. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, we conclude that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

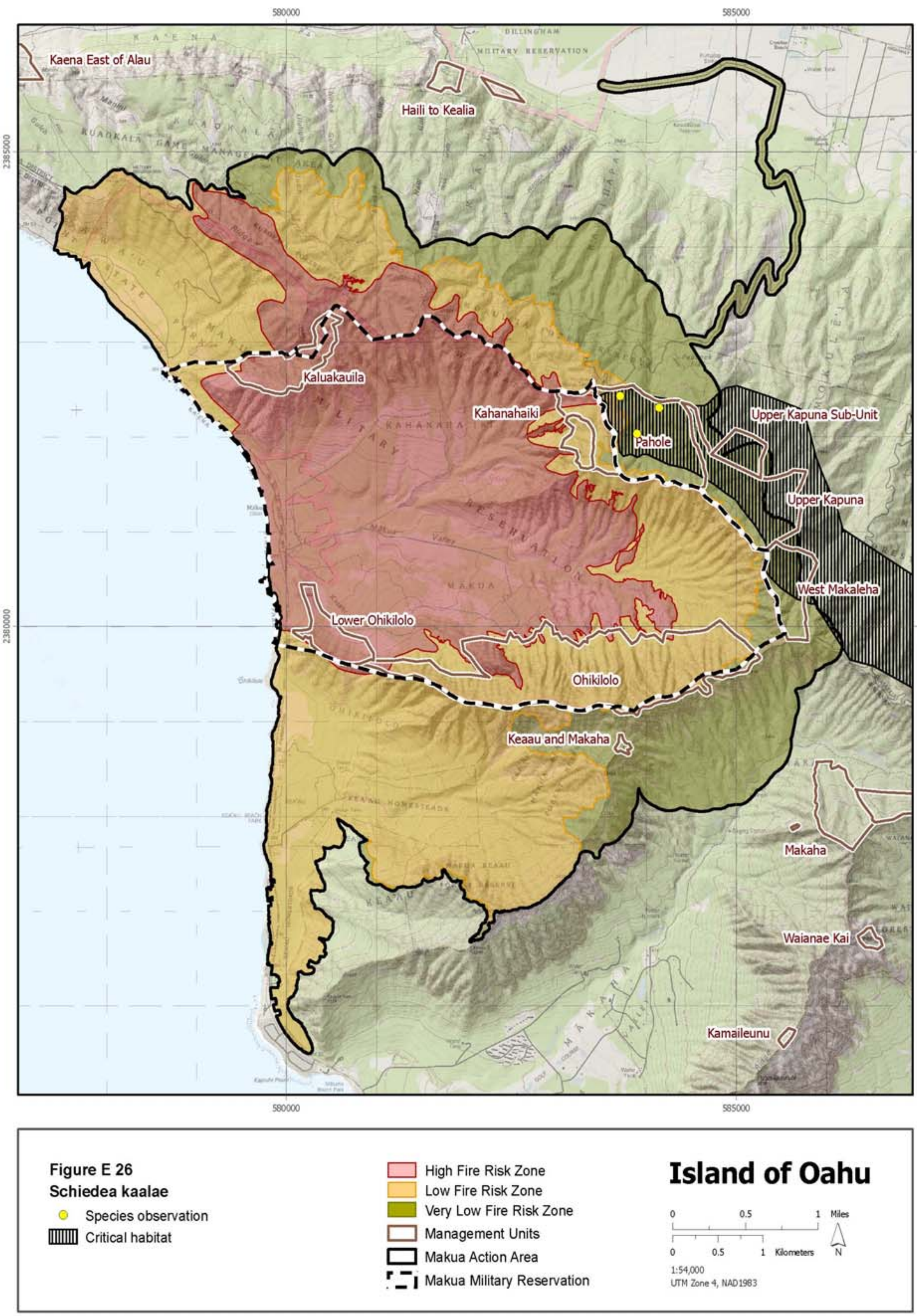
Effects of the Action on *Schiedea kaalae* Critical Habitat

Critical habitat for *Schiedea kaalae* comprises 14 percent (151 ha; 372 ac) of the total critical habitat for this species in the Makua action area (see Figure E 26). The unit for *S. kaalae* is located in the northeastern portion of the action area within the two low fire risk zones, with 7.4 ha (18.2 ac) in the low fire risk area and 143 ha (353.6 ac) in the very low fire risk area. This critical habitat, together with 123 ha (304 ac) outside the action area, was designated to provide habitat for the conservation of two populations of *S. kaalae* in order to meet the recovery goals for this species. At least 300 mature, reproducing individuals will comprise each population (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, steep slopes, cliffs, stream banks, or deep shade in diverse mesic or wet forests. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within diverse mesic or wet forests. It is estimated that almost one-half of the critical habitat is located in forest habitat with less than 50 percent native plant cover (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004; 68 FR 35950; 68 FR 35950). This indicates that this critical habitat unit is somewhat degraded due to non-native plant encroachment.

There is a risk that a fire could impact this unit. Fire could spread east from the impact area or from discharge of a weapon outside of the impact area. Eighty-seven percent, or 131 ha (325 ac), of the critical habitat is located in the Upper Kapuna, Upper Kapuna Sub-unit, Pahole and West Makaleha management units. Due to the similarities of this critical habitat unit to *Schiedea obovata*, please see *S. obovata* for the detailed effects analysis regarding Army actions in this portion of Makua. Overall, the risk of fire to this critical habitat unit is reduced due to the spatial separation from the fire source, the low flammability of the surrounding vegetation (mesic or wet forests), and the beneficial resource management actions conducted by the Army in the management units, pursuant to the Makua Implementation Plan Addendum. The remaining critical habitat (20 ha; 47 ac) outside of the management units is buffered from the impact area by the management units themselves.

Conclusion

The critical habitat unit for *Schiedea kaalae* in the Makua action area is located almost entirely in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire to the critical habitat unit will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit that is adjacent to the Pahole Management Unit. Fuel reduction within the management units will further buffer the critical habitat unit from fire. The critical habitat that is within the Central and East Makaleha, Upper Kapuna Sub-unit, Pahole, Upper Kapuna, and the West Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *S. kaalae* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *S. kaalae* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *S. kaalae*.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Kaena East of Alau
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Lower Ohikilolo
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Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 26
Schiedea kaalae
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
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UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Tetramolopium filiforme* (No Common Name)

Of the 3,500 total range-wide individuals of *Tetramolopium filiforme*, 3,428 (98 percent) grow within the Makua action area (Figure E 27). *Tetramolopium filiforme* is a diminutive perennial shrub that occurs in two morphologically differentiated varieties: *T. filiforme* var *filiforme* and *T. filiforme* var *polyphyllum*. Forty five individuals grow on the north aspect of C-Ridge below the Kahanahaiki Management Unit, 1,000 plants (primarily var. *polyphyllum*) grow at the lower, dry, western end of the Ohikilolo Management Unit, 2,298 plants of both varieties grow farther up on Ohikilolo Ridge, and 88 occur in the Keaau population unit. Three small population units (containing 9, 25, and 39 *T. filiforme* individuals) occur in the northern Waianae Mountains, southeast of the action area. The smallest population unit, Kalena, containing nine plants, occurs in the upper reaches of the action area for the Schofield Barracks West Range, where it is exposed to threats associated with Army training covered on that range (Service 2003). Recent declines, apparently due to feral ungulate pressure to plants growing south (outside) of the Ohikilolo ungulate exclusion fence, have been marked. The Army is managing this species as a stabilization species because of its restricted distribution outside the action areas. Numerical criteria for stability are four population units containing 50 reproducing individuals each. Currently only the Ohikilolo population meets the numerical stabilization criteria. *Tetramolopium filiforme* has a high background risk of extinction due to its low numbers, occurrence in dry fire-prone areas, ungulate impacts, and possibly, infestation by non-native scale insects (see General Effects).

<u>Species Response to the Proposed Action</u>

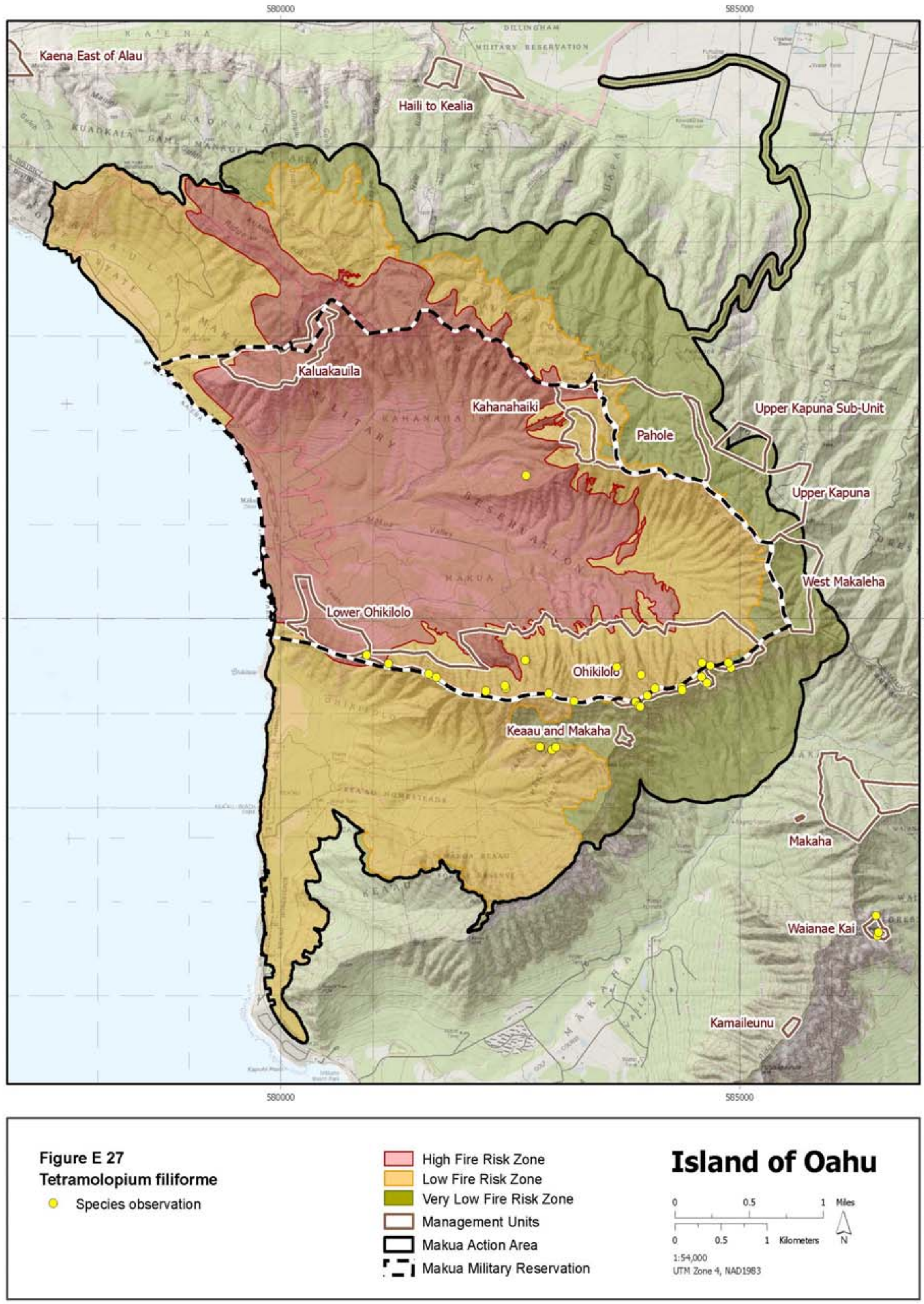
The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Tetramolopium filiforme* individuals in the action area. Thirty percent of all existing *T. filiforme* individuals grow within the high fire risk zone in the Makua action area. A fuelbreak will be completed, prior to the implementation of Column C weapons restrictions, to protect the 1,000 *T. filiforme* growing at the junction of Ohikilolo and Lower Ohikilolo management units from fires burning outside the firebreak road at Makua (see Figure PD 11). In the last 30 years, an Army-caused fire is recorded to have burned the site occupied by the 1,000 *T. filiforme* in the lower area of Ohikilolo Management Unit (see Figure E 1). Proposed weapons and prescribed burning restrictions, fire suppression staffing requirements, and increased grass mowing around the interior of the south lobe of the firebreak road minimize the likelihood that a fire will threaten the *T. filiforme* in the Ohikilolo area prior to the implementation of Column C weapons restrictions.

The 45 plants growing on the north aspect of C-Ridge, outside the Kahanahaiki Management Unit, grow in cracks on a near vertical rock cliff (S. Ching, pers. comm. 2007) that is likely to remain unburned, even though it is within the high fire risk zone. The vegetation in the drainage below the cliff is composed primarily of Kukui and is therefore not conducive to fire spread. The other 2,383 *T. filiforme* individuals growing within the Makua action area grow in locations high on the cliffs in the Ohikilolo Management Unit, and in the Keaau population unit, in the low and very low fire risk zone, where they are unlikely to be burned as a result of the proposed action. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could permit these fires to burn more than 100 acres in a 48-hr period (see General Effects - Fire Suppression).

Stabilization actions proposed by the Army, including augmentations, ungulate control, Army fire suppression assistance, and genetic storage, increase the probability that this species will persist. Eighteen of the 28 mature individuals outplanted by Army Natural Resources Staff at the Puhawai population unit (where only six naturally occurring plants grow) survived after four months in the field (64 percent survival rate). The Ohikilolo stabilization population unit, which contains 87 percent of all individuals of this species, is fenced and the entire Makua Valley will be fenced and ungulate free within 5 years. Fencing and ungulate control scheduled for the Waianae Kai population unit in 2011 are expected to result in increases in numbers and vigor of *in situ* plants at that site. Army fire suppression aid, particularly helicopter support, on State and City and County wildland fires that threaten the Puhawai and Waianae Kai population units will help ensure the persistence of *T. filiforme* at these sites.

Conclusion

Thirty percent of all existing *Tetramolopium filiforme* individuals grow within the high fire risk zone in the Makua action area. Weapons restrictions, fire suppression staffing, and new fuelbreaks and firebreaks will minimize the risk of a fire burning many of these *T. filiforme* plants. One thousand of them will be protected with a fuelbreak and the rest grow on a near vertical rock cliff which is likely to remain unburned. The potential damage or loss of *T. filiforme* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Stabilization actions, including population unit augmentations, ungulate control, and genetic storage, in addition to fire suppression aid which the Army will be providing, increase the probability that this species will persist. The overall effect of the proposed action's stressors and subsidies will result in a net increase in the numbers, distribution, and reproductive success of *T. filiforme* in and adjacent to the action area over the next 30 years. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.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Pahole
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EFFECTS OF THE ACTION – *Viola chamissoniana* ssp. *chamissoniana* (Pamakani)

Viola chamissoniana ssp. *chamissoniana* is a short-lived perennial endemic to the Waianae mountain range on Oahu. The estimated range-wide abundance of *V. chamissoniana* ssp. *chamissoniana* is 620 individuals (595 mature and 25 immature) with approximately 80 percent (500 plants) located in the action area, primarily in the Ohikilolo and Keaau Management Units (Figure E 28). All of these individuals are exposed to the suite of threats as described and analyzed in the General Effects section. *Viola chamissoniana* ssp. *chamissoniana* has a high background risk of extinction due to its low numbers and multiple threats. The Army is managing this species as a stabilization species.

Analysis of Effects of the Proposed Action

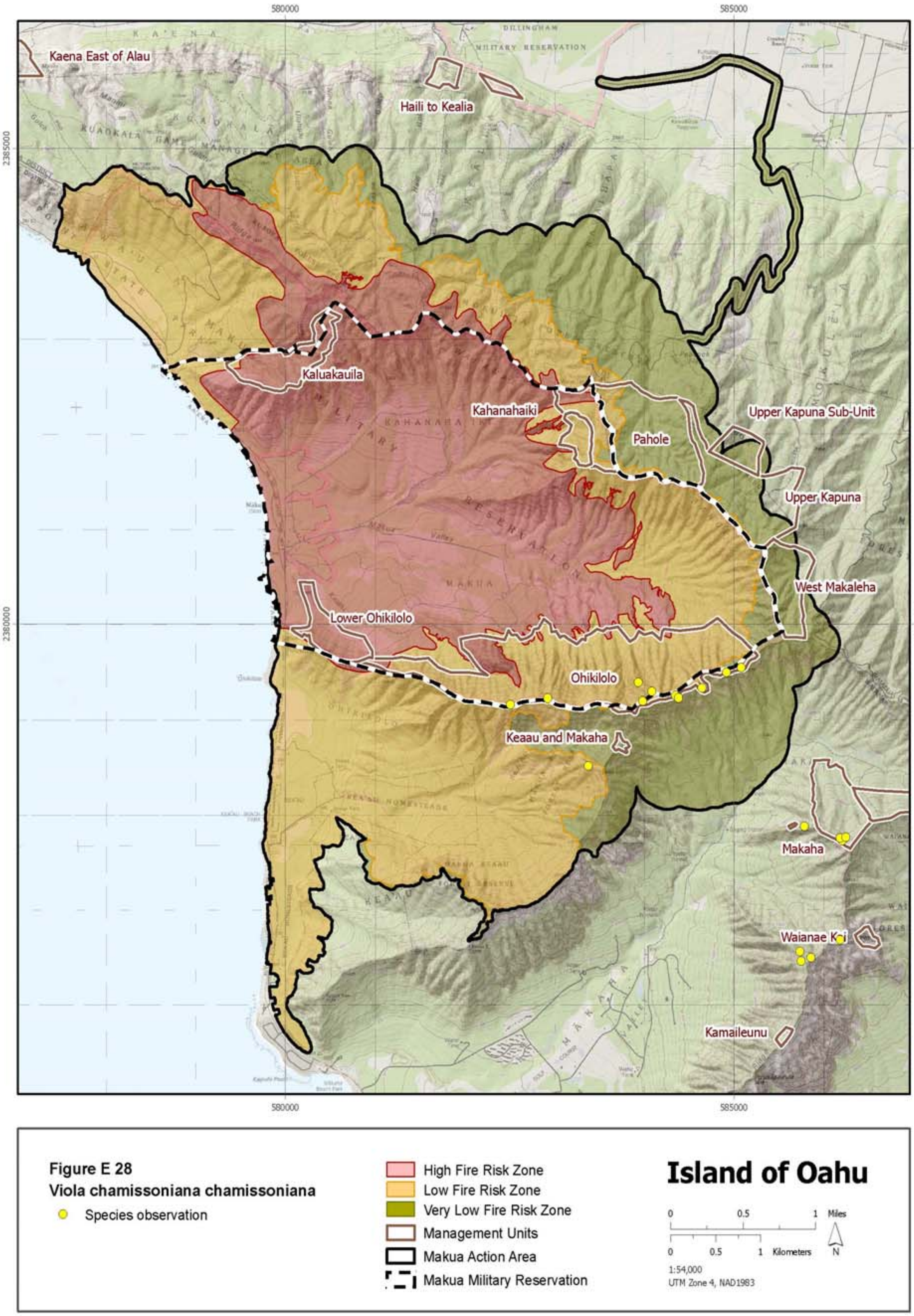
Over the next 30 years, *Viola chamissoniana* ssp. *chamissoniana* individuals could be exposed to the indirect and direct effects of a training-related wildland fire. The majority of the naturally occurring *V. chamissoniana* ssp. *chamissoniana* (approximately 450 mature and 20 immature) are located in the low fire risk zone with 25 individuals found in the very low fire risk zone. Three of the eight population units of *V. chamissoniana* ssp. *chamissoniana* are located along the higher reaches of the Ohikilolo Ridge (731 m; 2,400 ft elevation) distributed across 3.2 km (2 mi). The result of a wildland fire could be the direct loss of any plants in the path of the fire. Indirect effects include heat, ash, erosion and post recruitment of non-native plants. The loss of topsoil due to fire-induced erosion could be very detrimental to plants growing on steep, vertical crevices. A wildland fire could spread into Ohikilolo Ridge from the valley floor, or a fire may ignite on the ridge by a misfired long-range, live-fire weapon such as the TOW, or from a spot fire resulting from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression).

The risk assessment for this species includes several factors such as plant location, distribution and distance from the impact area. The risk of a wildland fire spreading from the valley floor (impact area) up the ridge is very low due to the distance from the impact area and the fire suppression measures that will be enacted that will slow or stop the fire prior to impacting Ohikilolo Ridge (see General Effects – Fire Suppression). In addition, the spread of a wildland fire would be limited due to the discontinuous fuels on the cliffs and therefore, the risk of affecting all plants in this area is minimal.

Approximately 300 *Viola chamissoniana* ssp. *chamissoniana* in the action area are protected from ungulates by the recently installed Ohikilolo Ridge fence. These individuals benefit from the exclusion of ungulates, which reduces grazing pressure. Other individuals of *V. chamissoniana* ssp. *chamissoniana* not in fenced exclosures are relatively inaccessible to ungulates due to their location on steep cliffs. The Army is actively attempting to control threats to this species with additional fencing in the Makaha Management Unit. The Ohikilolo population unit in the action area has reached numeric stabilization goals with approximately 400 mature individuals; however, all threats have not been abated. Other population units are showing an increasing trend in mature individuals.

Conclusion

Eighty percent of the known *Viola chamissoniana* ssp. *chamissoniana* plants occur in the action area and are located in the low to very low fire risk zones. The Army's training related impacts to this species will be offset by completing stabilization actions including outplanting, weed management, fence installation and reducing potential ongoing threats from ungulates and other invasive species. The Army's management actions for this species are expected to increase the abundance and distribution of this species in the Waianae Mountain Range over time. Army weapons restrictions, fire suppression staffing, and the fuels management program are designed to minimize the risk of fire damage to the *V. chamissoniana* ssp. *chamissoniana* growing within the action area. While there is a risk of a training related wildland fire affecting *V. chamissoniana* ssp. *chamissoniana,* the risk is considered minimal. While any loss of individual plants will be significant to the survival of *V. chamissoniana* ssp. *Chamissoniana* as a taxon, genetic storage, and other proposed fire management and stabilization actions, will offset such loss. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.


580000
585000
2385000
2380000
Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 28
Viola chamissoniana chamissoniana
Species observation
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION ON AT-RISK (EXPEDITED) TAXA

The 12 taxa listed below have been identified as particularly at risk of extinction in the action area, based primarily on their overall status, environmental baseline within the action area, and exposure to the risk of training-related wildland fire (Table E 10). These at-risk taxa were identified in late 2005 and early 2006, when the Service and the Army agreed to expedite stabilization as a conservation measure to protect these taxa from extinction while full stabilization measures are being implemented. Current data may reflect increases in abundance since 2003 as a result of the Army's ongoing efforts to stabilize these taxa. In 2005, at least 50 percent of all known remaining individuals and/or mature individuals of each of these at-risk taxa were located within the action area. Location within the action area by definition means these individuals are vulnerable to training-related wildland fire. Taxon-specific information supporting this group effects analysis for the 12 at-risk taxa are detailed in this section.

Chamaesyce herbstii (small tree)
Cyanea grimesiana ssp. *obatae* (shrub)
Cyanea longiflora (shrub)
Cyanea superba ssp. *superba* (small tree)
Delissea subcordata (shrub)
Gouania vitifolia (woody vine)
Hibiscus brackenridegei ssp. *mokuleianus* (shrub)
Neraudia angulata (shrub)
Phyllostegia kaalaensis (perennial herb)
Sanicula mariversa (perennial herb)
Schiedea nuttallii (subshrub)
Schiedea obovata (subshrub)

Status Summary of At-Risk Taxa

Abundance, distribution, and reproduction data for the 12 at-risk taxa are generally inadequate to predict changes in their baseline conditions over the next 30 years, with or without the proposed action. All taxa, except *Gouania vitifolia,* are limited in distribution to a few known population units on Oahu. When the Service and the Army agreed to expedited stabilization measures for these at-risk taxa in 2006, the range-wide total of known individuals of all taxa except *Hibiscus brackenridgei* ssp. *mokuleianus* consisted of less than 350 naturally occurring, *in situ* individuals. The total number of known individuals of *Chamaesyce herbstii*, *Gouania vitifolia*, *Phyllostegia kaalaensis*, and *Schiedea nuttallii* is less than 100. For 10 of the at-risk taxa none of the population units outside the action area meet or exceed stabilization targets for number of mature individuals, and five have no such population units at any location. Due to the low number of mature, reproducing individuals and lack of sufficient population units that meet or exceed the required number of individuals for stabilization populations, all 12 at-risk taxa are considered to have a very high background risk of extinction both in the action area and range-wide. Thus, expedited stabilization is necessary to protect these taxa from extinction while the Army is working to implement improved fire protection and suppression measures, and while long-term conservation measures are being implemented for full stabilization of all 28 plant target taxa.

Gouania vitifolia is the only at-risk species with individuals on another island (two known individuals on the island of Hawaii). About 98 percent of all individuals on Oahu, and about 95 percent of all individuals State-wide, are located within the action area. *Hibiscus brackenridgei* ssp. *mokuleianus* is the only at-risk taxon with a relatively substantial number of *in situ* individuals range-wide. However, only 48 of its total 669 *in situ* (naturally occurring)

Table E 10. Status and Environmental Baseline of at-risk Taxa (U.S. Army Garrison 2006d).

Taxon	**Total Number of Individuals (mature/immature)**	**Percent of Total Individuals in the Action Area**	**Number of Stabilization Population Units Exceeding Minimum Number of Individuals (existing‡/required)**	**Number of Stabilization Population Units Exceeding Minimum Number of Individuals Outside Action Area (existing‡/required)**	**Population Units with Fences (existing/required)**	**Fire Risk‡**
Chamaesyce herbstii	87 (51/36)	100	1/3	0/2	1/3	V
Cyanea grimesiana ssp. *Obatae*	254 (134/120)	16	1/3	0/2	3/3	V
Cyanea longiflora	171 (80/91)	92	0/3	0/1	1/3	L, V
Cyanea superba ssp. *superba*	311 (171/140)	50	2/4	1/3	2/4	L, V
Delissea subcordata	185 (173/12)	12	1/4	1/3	3/4	L, V
Gouania vitifolia	81 (81/0)*	95	1/3	0/2	0/3	V
Hibiscus brackenridegei ssp. *Mokuleianus*	669 (48/621)†	3	0/4	0/3	1/4	H
Neraudia angulata	380 (227/153)	21	0/4	0/2	2/4	H,L
Phyllostegia kaalaensis	2 (0/2)	100	0/3	0/2	0/3	V
Sanicula mariversa	224 (18/206)	87	0/3	0/1	1/3	L, V
Schiedea nuttallii	94 (83/11)	100	1/3	0/1	1/3	L, V
Schiedea obovata	389 (158/231)	100	2/3	0/1	1/3	L, V

*State-wide
†*in situ* only
‡ Individuals may not be reproducing successfully due to threats which have not yet been abated.
‡Fire Risk: H (high), L (low), V (very low)

individuals are mature plants, and the one existing population unit in the action area represents 33 percent of the total mature individuals for this taxon range-wide. When the Service and the Army first began discussing expedited stabilization for at-risk species, the action area individuals of *H. brackenridgei* ssp. *mokuleianus* represented 50 percent of the mature individuals range-wide. Although there are a considerable number of seedlings at some sites, the survival and eventual reproductive success of these immature plants, especially those in unfenced areas, is uncertain.

Five of the at-risk taxa do not meet stabilization targets for the number of mature individuals for stabilization population units (*Cyanea longiflora*, *Hibiscus brackenridgei* ssp. *mokuleianus*, *Neraudia angulata*, *Phyllostegia kaalaensis*, and *Sanicula mariversa*). Seven taxa (*Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea superba* ssp. *superba*, *Delissea subcordata*, *Gouania vitifolia*, *Schiedea nuttallii*, and *Schiedea obovata*) each have at least one population unit that meets or exceeds stabilization targets for the number of mature individuals. However, these population units are not considered fully stabilized because they are not self-sustaining (i.e., there is little natural recruitment), threats are not controlled (e.g., fire, invasive plants, slugs), and *ex situ* genetic storage is not complete.

Seven of the at-risk taxa appear to be increasing in abundance since initiation of the Makua Implementation Plan in 2003. However, the apparent increases of *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyanea longiflora*, *Cyanea superba* ssp. *superba*, *Neraudia angulata*, *Schiedea nuttallii*, and *Schiedea obovata* are due primarily to Army augmentation and reintroduction efforts. Recruitment in the wild is poor for most of these taxa, primarily because of slugs, for which there is no known feasible control method in natural environments. The apparently increasing trend in abundance of *Chamaesyce herbstii*, *Cyanea longiflora*, *Gouania vitifolia*, and *Neraudia angulata* is likely due in part to new discoveries of previously unknown individuals. Six at-risk taxa are prone to wide fluctuations in population size and have recent histories of decline: *Cyanaea grimesiana* ssp. *grimesiana*, *Cyanea longiflora*, *Delissea subcordata*, *Neraudia angulata*, *Phyllostegia kaalaensis*, and *Schiedea obovata*. All naturally occurring individuals of *Cyanea superba* ssp. *superba* and *P. kaalaensis* have become extirpated in the wild since completion of the Makua Implementation Plan, and all currently existing individuals have been reintroduced from greenhouse-propagated stock.

Hibiscus brackenridgei ssp. *mokuleianus*, *Phyllostegia kaalaensis*, and *Sanicula mariversa* are the only taxa that appear to be decreasing in the total number of individuals, even with stabilization management under the Makua Implementation Plan Addendum. There is not sufficient data to determine a trend in abundance of *S. mariversa*, because population viability data is lacking on long-term survival and reproduction rates. This species undergoes a complex summer dormancy period, from which many individual plants fail to reappear from year to year. In addition, flowering is infrequent and inconsistent, and plants apparently die after flowering only once. Until the life history and population viability of *S. mariversa* are better known, this species must be considered at-risk.

When their threats are managed (ungulate fencing, weed control, predator control) only two at-risk taxa, *Hibiscus brackenridgei* ssp. *mokuleianus* and *Sanicula mariversa*, are thought to successfully recruit in the wild. Nonetheless, reintroductions will be needed to meet stabilization targets for the number of mature reproducing individuals for these two taxa (U.S. Army Garrison 2006d). Seven at-risk taxa produce seedlings in the wild or at reintroduction sites, but only rarely, and some may have uncontrollable threats (e.g., slugs or black twig borers); all will require reintroduction to establish the required number of mature reproducing individuals: *Chamaesyce herbstii*, *Cyanea longiflora*, *Cyanea grimesiana* ssp. *obatae*, *Delissea subcordata*, *Neraudia angulata*, *Schiedea obovata*, and *Schiedea nuttallii* (U.S. Army Garrison 2006d). Two at-risk taxa, *Cyanea superba* ssp. *superba* and *Phyllostegia kaalaensis*, have never produced any known seedlings in the wild or at reintroduction sites, so reintroduction methods for these taxa will require additional research (U.S. Army Garrison 2006d). Little is known about the recruitment potential of the remaining at-risk taxon, *Gouania vitifolia*.

Due to small population size, restricted distribution in only one population unit, limited recruitment, and declining trends in abundance and distribution, these 12 at-risk taxa already are in a phase of quasi-extinction. The number of individuals has declined to the point where demographic or environmental stochasticity alone can result in extirpation. We infer from these circumstances, conservation biology principles, and examples from other species that these taxa have a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence.

<u>Analyses for Effects of the Action</u>

Individuals of the 12 at-risk taxa in the action area will be exposed to training-related wildland fire and the ongoing impacts of non-native species. Effects of human disturbance (trampling) are considered minor, except for *Phyllostegia kaalaensis*, which has a root system particularly vulnerable to soil compaction. Life forms of these taxa include an herbaceous plant, a woody vine, partially woody subshrubs, and woody shrubs and small trees of the understory. All individuals and life stages are vulnerable to high and low severity fires throughout the year, depending on phenology and the time of year fire occurs.

Individuals of these 12 taxa will be exposed to the direct and indirect effects of training-related wildland fire over the next 30 years, due to their occurrence within the action area in zones at high, low, or very low risk of training-related wildland fire (Table E 11). All individuals and life stages are vulnerable to high and low severity fires throughout the year. At-risk taxa with individuals located in areas at high risk of fire are *Hibiscus brackenridgei* ssp. *mokuleianus* and *Neraudia angulata*. These plants are likely to be burned under certain conditions. Even full staffing of on-site and standby fire suppression helicopter forces will not guarantee containment of all fires. On approximately 1.5 percent of historical potential training days analyzed, on-site and standby helicopter containment would have failed to contain a fire burning outside the firebreak road, if the fire had not been successfully contained before 1 pm. If additional contingency fire suppression resources are not called, these fires would escape initial attack and burn large acreages. Large fires and fires escaping initial attack are likely to burn into the native forest (see General Effects – Fire Suppression) before additional helicopter support can arrive on-site. In addition, *Hibiscus brackenridgei* ssp. *mokuleianus* plants in the Lower Ohikilolo Management Unit are particularly vulnerable to training-related wildland fire unless fuel modifications are completed, because they are located on a dry, grassy slope that has burned in the past.

Table E 11. Exposure Area for At-Risk Taxa (U.S. Army Garrison 2006c).

Taxon	Individuals in Fire Risk Zones[†]		
	High	Low	Very Low
Chamaesyce herbstii	0	0	87 (100)
Cyanea grimesiana ssp. *obatae*	0	0	42 (16)
Cyanea longiflora	0	56 (33)	94 (54)
Cyanea superba ssp. *superba*	0	21 (7)	134 (43)
Delissea subcordata	0	20 (11)	2 (1)
Gouania vitifolia	0	0	77 (95)
Hibiscus brackenridgei spp. *mokuleianus*	20 (3)	0	0
Neraudia angulata	32 (8)	48 (13)	0
Phyllostegia kaalaensis	0	0	2 (100)
Sanicula mariversa	0	52 (23)	128 (57)
Schiedea nuttallii	0	84 (89)	10 (11)
Schiedea obovata	0	91 (23)	298 (77)

[†]Total number of individuals (percent of total individuals occurring in fire risk zone).

Plants growing outside the high fire risk zone in the action area are at low risk of burning from training-related wildland fire. At-risk taxa with individuals located in the low fire risk zone include *Cyanea longiflora*, *Cyanea superba* ssp. *superba*, *Delissea subcordata*, *Neraudia angulata*, *Sanicula mariversa*, *Schiedea nuttallii*, and *Schiedea obovata*. These plants can burn in fires that spread from fires that ignite in the high fire risk zone, from misfired or malfunctioning long-range weapons systems and munitions (tracers, AT-4 and SMAW anti-tank weapons, 2.75-caliber rockets, Javelin anti-tank missiles, and TOW missiles), and from spot fires spawned from intense fires in Makua Valley. Under certain adverse conditions (such as an unreported fire during an extreme drought), fires that spread into the low fire risk zones may burn to the outer boundary of the very low fire risk zone within 48 hours.

Plants growing outside the low fire risk zone are at very low risk of burning as a result of training-related wildland fire ignited by a misfired or malfunctioning Javelin or TOW projectile, or a spot fire from an intense fire burning in Makua Valley under certain dry, windy weather conditions. At-risk taxa with individuals located in the very low fire risk zone include *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea longiflora*, *Cyanea superba* ssp. *superba*, *Delissea subcordata*, *Gouania vitifolia*, *Phyllostegia kaalaensis*, *Sanicula mariversa*, *Schiedea nuttallii*, and *Schiedea obovata*. These plants can burn within spot fires of various sizes, depending on topography, vegetation cover, weather, and suppression capability. The expected fire size resulting from a misfired long-range Javelin or TOW projectile landing within intact shrub and/or forest vegetation is about 0.1 ha (0.3 ac) with immediate fire suppression response; if a fire is undetected, it could burn over 100 acres in 48 hours.

At-risk taxa were originally identified, in part, because of their rather high risk of training-related wildland fire, as predicted by preliminary fire models (Beavers 2005). Additional fire modeling based on the Army's intention to significantly upgrade its fire-fighting capability shows a serious reduction to the originally predicted fire risk (D. Greenlee, pers. comm. 2007). Based on improvements to the Army's Wildland Fire Management Plan, which is included as part of the Project Description, the currently predicted fire risk to most of these 12 taxa is low. However, the success of any fire suppression response will depend on rigorous adherence to requirements that include a complex system of weather forecasting, fire danger monitoring, and skilled deployment of fire fighting personnel and equipment. We anticipate fires that ignite or spread outside the firebreak road will be contained as quickly as possible utilizing direct attack with fire suppression helicopters. Nonetheless, we also recognize that unavoidable human errors, accidents, and delays occur on fires, reducing the effectiveness of fire suppression operations (see General Effects - Fire and Fire Suppression). Even a fire that burns only up to a management unit fenceline, without destroying listed plants within the unit, may damage the fence enough to allow a period of ungulate access to at-risk population units. In addition, even with Army management, two at-risk taxa (*Cyanea superba* ssp. *superba* and *Phyllostegia kaalaensis*) have ceased to exist in the wild as naturally occurring plants; all extant individuals were outplanted from greenhouse-propagated stock. Most importantly, the Army is concerned about the long-term adequacy of funding for fire protection and stabilization activities (U.S. Army Garrison 2006d). Therefore, we have retained the designation of at-risk taxa because we consider even a low risk of fire or ungulates as potentially damaging to these critically endangered taxa.

The areas exposed to training-related wildland fire and invasive species in the action area include mixed native and non-native vegetation in mesic forest, dry forest, and dry grassland/shrubland habitats. Population units of several taxa (*Cyanea superba* ssp. *superba*, *Delissea subcordata*, *Hibiscus brackenridgei* ssp. *mokuleianus*, *Neraudia angulata*, *Schiedea nuttallii*, and *Schiedea obovata*) are at high risk of training-related wildland fire within dry, grassy habitats of the Kaluakauila, Lower Ohikilolo, and Kahanahaiki (C-Ridge vicinity) management units. Population units within mesic, forested habitats in the Kahanahaiki, Pahole, Upper Kapuna, and West Makaleha management units are generally at lower risks of fire, except in areas of alien grass encroachment. Population units in the Ohikilolo Management Unit along the south valley rim and in the Keaau area beyond Ohikilolo Ridge are likewise at lesser risks of fire. Mesic conditions in upper-slope forests do not preclude the incidence of fire, however, especially during prolonged drought conditions in disturbed areas with grassy understories. The spread of wildland fire from the northern C-Ridge area into the Kahanahaiki Management Unit, for example, is strongly influenced by grass. The 1995 and 2003 escaped prescribed burns increased the exposure of listed plants near this area to future fires by killing native vegetation and increasing the alien grass cover. Less than half of the population units to be managed for stability of at-risk taxa are located within fenced areas, and not all of them are regularly controlled for invasive weeds. Individuals under mesic forest canopy in weed control areas are probably fairly well protected from rapidly spreading intense fire. Other individuals in locations lacking weed control are not well protected from long-term fire encroachment into native and mixed forest.

To reduce the risk of training-related wildland fire to listed plants, the Army will use certain types of weapons systems and munitions for training at Makua only after completion of specific measures to protect at-risk taxa and augment their numbers in the wild to expedite their stabilization. In addition, as part of the proposed action, the Army will implement conservation and stewardship programs to reduce the risk of ignition and spread of training-related wildland fire, reduce the loss of plants in wildland fires occurring on State and private land outside the action area, and improve native habitat in population units by excluding feral ungulates and controlling non-native weeds (Makua Implementation Plan Addendum).

Table E 12. Expedited Stabilization Population Units Located on State, City/County, and Private Lands; All Taxa Except *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Gouania vitifolia*, and *Phyllostegia kaalaensis* also have population units on Army lands (U.S. Army Garrison 2006d).

Taxon	State Lands	City/County Lands	Private Lands
Chamaesyce herbstii	Upper Kapuna to Pahole* W Makaleha	Makaha	
Cyanea grimesiana ssp. *obatae*	Pahole to W Makaleha*		Central Kaluaa Palikea (S Palawai)
Cyanea longiflora	Upper Kapuna to W Makaleha* Makaha & Waianae Kai Pahole*	Makaha & Waianae Kai	
Cyanea superba ssp. *Superba*	Central & E Makaleha Pahole to Kapuna	Makaha	
Delissea subcordata	Kahanahaiki to Keawapilau*		Ekahanui Kaluaa
Gouania vitifolia	Keaau* Waianae Kai*		
Hibiscus brackenridgei ssp. *mokuleianus*	Keaau*		Haili to Kawaiu Kaimuhole & Palikea Gulch
Neraudia anugulata	Manuwai Waianae Kai Mauka		
Phyllostegia kaalaensis	Keawapilau to Pahole* Manuwai	Makaha	
Sanicula mariversa	Kamaileunu Keaau*		
Schiedea nuttallii	Kahanahaiki to Pahole* Upper Kapuna-Keawapilau Ridge	Makaha	
Schiedea obovata	Kahanahaiki to Pahole* Keawapilau to WMakaleha*	Makaha	

*Entirely or partially inside action area

The risk of fire to listed species occurring inside the action area will be minimized by training restrictions, fire management, and expedited stabilization actions. Fire minimization measures are based on required levels of helicopter staffing to contain fires before they escape the firebreak road. In addition, to reduce the fire risk to *Hibiscus brackenridgei* ssp. *mokuleianus* plants (as well as to the stabilization taxon *Chamaesyce celastroides* var. *kaenana*) in the Lower Ohikilolo Management Unit, the Army will not begin any live-fire or blank-fire training until alien grass cover is removed and controlled within 3 m (9.8 ft) of these plants and to less than 20 percent cover within the Lower Ohikilolo weed control areas. Additional fuels modification within a 60-m (197-ft) swath along the inside perimeter of the south firebreak road, as shown in Figure PD 6 will allow the Army to reduce the level of on-site helicopter staffing required for certain weapons. With these fuel modifications in place, the Army may train using small arms, demolitions, grenades, mines, simulators, and mortars and artillery, with the use of certain of these weapons systems and munitions restricted to Green fire danger conditions. Within five to 10 years, plants growing in the Kahanahaiki and Kaluakauila management units will be protected by fuels modification and firebreaks; these protections will benefit at-risk taxa noted above. With these management units better protected from fire, and with completion of expedited stabilization of *Cyanea superba* ssp. *superba*, *Schiedea nuttalli*, and *Schiedea obovata*, the Army may begin training with more weapons systems and munitions under Yellow fire danger conditions instead of only under Green fire danger conditions; and begin using grenade launchers and AT-4 and SMAW weapons under Green or Yellow fire danger conditions, depending on live herbaceous fuel moisture. Expedited stabilization of the 12 at-risk taxa must be complete before the Army may begin training with tracer ammunition, Javelins, and 2.75-caliber rockets. Thus, all listed species in the action area, including the 16 stabilization taxa, will benefit from training restrictions required until expedited stabilization is complete for all 12 at-risk species. Full stabilization of all 16 stabilization taxa and all 12 at-risk taxa must be complete before the Army may begin training with TOWs.

<u>Species Response to the Proposed Action</u>

The response of individuals of at-risk taxa to training-related wildland fire and invasive species will include the direct and indirect effects of fire injury and death, ungulate grazing and trampling, invertebrate herbivory, and alien plant competition (see General Effects). As a result, the number of mature individuals and numerically stable population units of at-risk taxa in the action area are expected to decline over the next 30 years. The overall response to direct and indirect effects will be a measurable reduction in baseline numbers, distribution, and reproduction of individuals and/or entire occurrences in action area population units due to fire injury and death. Reduced individual fitness in plants that survive will further decrease the viability of population units through a continuing decline in baseline numbers. Without implementation of the Army's conservation and stewardship programs, these effects will worsen the existing condition of at-risk taxa in the action area by constraining their resiliency (recovery rate from disturbance) and exacerbating their risk of extinction due to small population size. We infer from conservation biology principles and examples from related species that these at-risk taxa have very high background extinction risks due to demographic, environmental, and catastrophic events in the action area. We conclude that any additional threats to at-risk taxa are likely to eliminate expectation of their long-term persistence.

The Service anticipates that implementation of fire management and expedited stabilization actions will prevent training-related declines in baseline numbers of individuals and population units of at-risk taxa. Over the next 30 years, expedited stabilization is expected to achieve modified numerical stability of threshold numbers of mature and immature individuals in at least three population units, including one or two outside the action area, for each at-risk taxon. (Full stabilization over the long term will require threshold numbers of mature, reproducing individuals, full threat control, and full *ex situ* genetic storage for all population units.) The Army recently decided to identify four manage for stability population units for some of the at-risk taxa (U.S. Army Garrison 2006d). The criteria used to identify taxa that will be managed at four stabilization population units include (1) presence in both the Makua and Schofield Barracks (Service 2003) action areas (*Delissea subcordata*); (2) presence in high fire threat areas in the Makua action area (*Hibiscus brackenridgei* ssp. *mokuleianus*); (3) need for reintroduction to achieve stabilization population goals (*Hibiscus brackenridgei* ssp. *mokuleianus, Cyanea superba* ssp. *superba*); and (4) need for an additional population unit to represent the full geographic and morphological diversity of the taxon (*Neraudia angulata, Cyanea grimesiana* spp *superba*).

Expedited stabilization goals can be attained for most of the at-risk taxa within about five to 10 years, while others (particularly *Sanicula mariversa*) may take longer (K. Kawelo, U.S. Army, pers. comm. 2006). Overall, the response of at-risk taxa to project subsidies is expected to result in measurable increases in individual fitness (survival, reproduction, and recruitment), increased total number of mature and immature individuals within population units, and expanded distribution of population units outside the action area. Thus, Army conservation and stewardship programs will protect these taxa from jeopardy over the next 30 years, improve their likelihood of reaching full stabilization goals over the long term, and enhance their probability of persistence.

Responses to project subsidies may involve indirect adverse effects to certain at-risk taxa. In particular, prioritizing augmentation and reintroduction of individuals and population units both inside and outside the action area may deplete seed sources and delay collection of material for *ex situ* genetic storage. In some cases, repeated outplantings to replace individuals that do not survive because of fire, ungulates, weeds, or invertebrate pests may create sink population units where reproduction and recruitment are insufficient to offset mortality. These impacts will be minimized by careful monitoring and addressing limiting factors to survival and recruitment through fuels, weed, and pest control measures. In addition, four at-risk taxa will be managed for stability at only one population unit outside the action area. Army biologists believe that action area locations of these taxa represent their currently known and historical centers of abundance (K. Kawelo, U.S. Army, pers. comm. 2006). For this reason, the Army believes scarce propagule resources should be used to augment current action area locations rather than introducing population units outside their historically documented range. Thus, these four taxa will still have an elevated exposure to training-related wildland fire, even when fully stabilized, because relatively fewer individuals will be located outside the action area. However, because the predicted fire risk to these taxa is low or very low, one population unit outside the action area is believed to be adequate. The Army and the Service will closely monitor these taxa and revise management actions as necessary to achieve and maintain expedited stabilization criteria.

The reasoning outlined above is based on information about the proposed action and the environmental baselines of the at-risk taxa in the action area. In addition, we make general inferences from this set of circumstances according to conservation biology principles regarding small populations and from previous experience regarding threats to the conservation of native vegetation in Hawaii (see General Effects). We also make inferences from examples of other species that are closely related to the at-risk taxa or have a similar life history, and have become unstable, endangered, or extinct.

The genus *Schiedea*, for example, contains the highest proportion of endangered taxa of any species-rich lineage in the Hawaiian Islands, with 19 taxa (about 54 percent) listed as endangered and three designated as candidates for listing (Wagner et al 2005; U.S. Fish and Wildlife Service

2005a). *Schiedea nuttallii* is closely related to *S. amplexicaulis* and *S. implexa*, which are presumed extinct, and to *S. kaalae*, a stabilization species that is endangered and unstable. *Schiedea obovata* is somewhat less closely related to these species but is also endangered and unstable. The declines of *S. nuttalllii*, *S. obovata*, and *S. kaalae* are attributed to habitat degradation by feral pigs and lack of seedling survival due to slug herbivory. According to Wagner et al (2005), loss of native forest in the Waianae Mountains are/were caused in part by military-related fires, and the coincidental high diversity of *Schiedea* in this area, probably have contributed disproportionately to endangerment in this genus. We believe that ongoing threats in the action area, if not addressed, are likely to further imperil at-risk *Schiedea* species to the point of extinction.

Similarly, 28 (49 percent) *Cyanea* taxa are listed as endangered, one is listed as threatened, eight (14 percent) are candidates for listing, and 17 (30 percent) are considered species of concern (U.S. Fish and Wildlife Service 2006a; Hawaii Biodiversity and Mapping Program 2006). In addition, four (44 percent) of the nine *Delissea* species are listed as endangered and several are presumed extinct. *Cyanea*, one of the largest Hawaiian plant genera, and the closely related genus *Delissea* are classified within the Lobelioideae subfamily of the Campanulaceae (bellflower family). The Hawaiian lobelioids are classic examples of adaptive radiation on isolated, oceanic islands. About 25 percent of lobelioid species have become extinct over the past 100 years (Wagner et al 1999). Six endemic lobelioid genera exhibit morphological diversity that is likely related to the role of endemic Hawaiian honeycreepers as pollinators, many of which are also endangered or extinct. At Makua, naturally occurring individuals of *Cyanea superba* ssp. *superba* have been extirpated since completion of the Makua Implementation Plan in 2003; this taxon (and the unrelated *Phyllostegia kaalaensis*) currently exist in the wild only as Army reintroductions from greenhouse-propagated stock. We infer from such examples that at-risk taxa in the action area are similarly threatened with extinction, given their unstable status, existing threats, and the potential impacts of the proposed action. These examples also illustrate the need to expedite stabilization of at-risk taxa before all naturally occurring individuals disappear.

<u>Conclusion</u>

Based on the analysis above, the Service anticipates that stressors associated with training-related wildland fire, and the introduction and spread of invasive species, are likely to result in decreased fitness of individuals and viability of population units of 12 at-risk taxa by reducing their abundance, distribution, and reproduction in the action area. Action area individuals will be exposed to high, low, and very low risks of burning as a result of a training-related wildland fire over the next 30 years. The response of at-risk taxa to a training-related wildland fire range from direct effects of injury and death to indirect effects of physiological stress, increased mortality, habitat degradation, and competition with non-native species. The overall effect of training-related wildland fire and spread of invasive species will be a further decline in individual fitness, baseline numbers, and viability of population units within the action area. The number of individuals in the action area population units represent from 12 to 100 percent of all known remaining individuals of each of these 12 at-risk taxa. With so few individuals remaining, these taxa have a greater risk of extinction, however, expedited stabilization greatly minimizes this risk for these 12 taxa.

We develop our opinion using the best available scientific and commercial information, giving benefit of the doubt to the species if significant information gaps preclude determination of quantifiable effects. For example, the proposed action's training-related wildland fire risk could be estimated more accurately with additional modeling to predict long-term fire frequency and encroachment into native forest, and with collection of adequate demographic data for population viability analysis of listed plants. Lacking that information, we infer from restricted distribution, small population size, and limited recruitment that at-risk taxa in the action area have a very high background risk of extinction. We believe any additional threats, including training-related wildland fire and habitat degradation by invasive species, are likely to eliminate expectation of their long-term persistence. Accordingly, we consider expedited stabilization of population units outside the action area, where they will not be exposed to training-related wildland fire, essential to persistence of these at-risk taxa in the wild. The reduced viability of action area population units, in the absence of stabilization population units outside the action area, may be sufficient to appreciably reduce the likelihood these species will persist.

Our conclusion is based on our best professional judgment of the likely response of at-risk taxa to both stressors and subsidies of the proposed action. Military training restrictions and conservation management to attain expedited stabilization will ensure that at least three population units at modified numerical thresholds for stability are maintained for each at-risk taxon, including one or two population units for each taxon outside the action area that will not be exposed to training-related wildland fire. We anticipate that expedited stabilization will protect at-risk taxa from jeopardy over the next 30 years while fire protection and suppression measures are being improved and long-term actions for full stabilization are being implemented. Therefore, after reviewing the current status of the 12 at-risk taxa, the environmental baseline for these taxa in the action area, and the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the following 12 at-risk taxa in the wild by reducing their reproduction, numbers, and distribution: *Chamaesyce herbstii*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea longiflora*, *Cyanea superba* ssp. *superba*, *Delissea subcordata*, *Gouania vitifolia*, *Hibiscus brackenridegei* ssp. *mokuleianus*, *Neraudia angulata*, *Phyllostegia kaalaensis*, *Sanicula mariversa*, *Schiedea nuttallii*, and *Schiedea obovata*.

EFFECTS OF THE ACTION – *Chamaesyce herbstii* (Akoko)

All 87 individuals of the Waianae endemic tree, *Chamaesyce herbstii*, are part of the Kapuna to Pahole population unit located in the Makua action area (Figure E 29). These individuals are growing in the Pahole (20) and Upper Kapuna (67) management units. The Kapuna to Pahole population unit is not considered stabilized (defined as 25 mature, reproducing individuals) because threats are not controlled and the plants are not naturally self-sustaining. *Chamaesyce herbstii* has been identified as particularly at risk in the action area, based primarily on their overall status, environmental baseline within the action area, and exposure to the risk of training-related wildland fire. *Chamaesyce herbstii* was identified as an expedited stabilization species as a conservation measure to protect these taxa from extinction while full stabilization measures are being implemented over the long term. *Chamaesyce herbstii* has a high background risk of extinction due to its very low numbers, low vigor, and apparent lack of pollinators. Due to small population size, restricted distribution, limited recruitment, and declining trends in numbers and distribution, *C. herbstii* already is in a phase of quasi-extinction with numbers that have declined to the point where demographic or environmental stochasticity alone can result in extirpation. We infer from these circumstances, conservation biology principles, and examples from other species that *C. herbstii* has a very high background extinction risk, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence.

Species Response to the Proposed Action

Over the next 30 years, *Chamaesyce herbstii* individuals in the Kapuna to Pahole population unit will be exposed to the direct and indirect effects of training-related wildland fire in the very low fire risk zone. However, the proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *C. herbstii* individuals in the action area. As a small tree, mature and immature individuals are vulnerable to high and low severity fires throughout the year. *Chamaesyce herbstii* in the action area also will be exposed to the direct and indirect impacts of non-native invasive plants, which have significantly altered the mesic habitat where this species occurs. The direct and indirect effects of non-native weeds and invertebrates will reduce the vigor, reproduction, recruitment, and survival of individual plants.

All *Chamaesyce herbstii* plants growing in the action area may be impacted by spot fires spawned by intense fires burning in Makua valley, or by fires ignited by a misfired long-range, live-fire weapon such as the TOW. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac) (see General Effects - Fire Suppression). In addition, reaching expedited stabilization goals (see Expedited Group Effects) will improve the likelihood that *C. herbstii* will attain full stabilization and enhance its probability of persistence over the long term. Implementation of all fire suppression measures incorporated into this action, as well as the Army's Standard Operating Procedures reduce the risk of *C. herbstii* destruction by fire over the next 30 years. Any loss of action area plants will reduce baseline numbers and available propagule material for augmentation and reintroduction, and prolong the time needed to achieve expedited and full stabilization.

The Pahole Management Unit is fenced to exclude feral ungulates, and weeds are partially controlled throughout the population unit. Because of their occurrence in mesic forest, *Chamaesyce herbstii* individuals are somewhat protected from the spread of fire. Moreover, no long-range weaponry will be used until expedited stabilization thresholds are achieved for all stabilization population units. Expedited stabilization will involve continued augmentation to maintain at least 25 individuals of *C. herbstii* in the Kapuna to Pahole population unit inside the action area. Outside the action area, the West Makaleha and Makaha population units will be established through reintroduction, after fence exclosures are constructed. *Chamaesyce herbstii* plants have been grown from wild-collected seed and successfully outplanted by State biologists since 1995.

Conclusion

Despite the ongoing exposure of *Chamaesyce herbstii* to project wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions minimize the risk of wildland fire to *C. herbstii.* Expedited and full stabilization pursuant to the Makua Implementation Plan Addendum will increase the number of *C. herbstii* to stability thresholds in three population units, including two outside the action area that will not be vulnerable to training-related wildland fire. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in population numbers, distribution, and reproduction of *C. herbstii* in and adjacent to the action area. Therefore, based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Chamaesyce herbstii* Critical Habitat

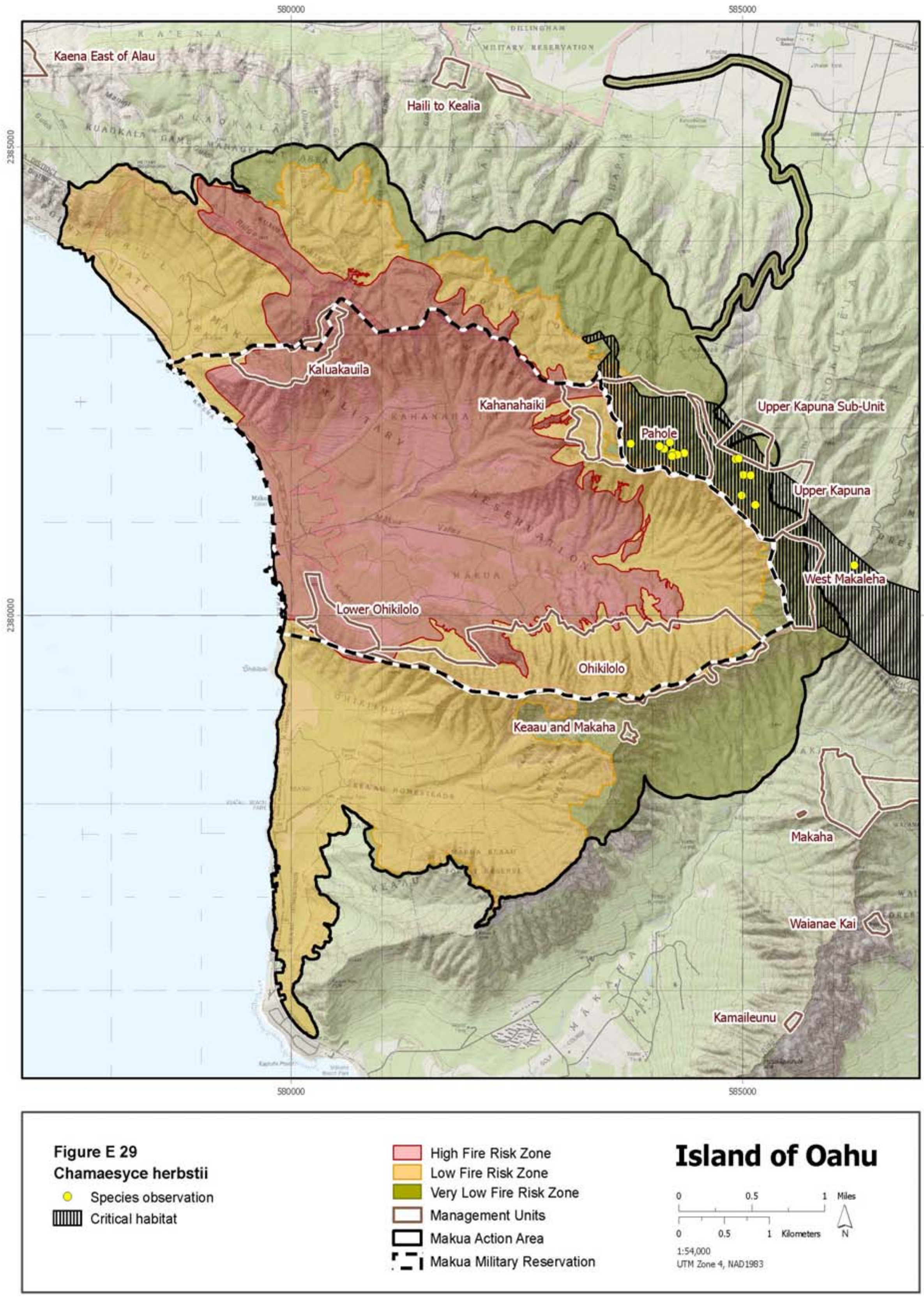
Forty-one percent or 205 ha (506 ac) of the total critical habitat designated for *Chamaesyce herbstii* is located in the Makua action area (see Figure E 29). It is located in the eastern portion of the action area and is almost entirely located in within the low fire zones with 19.7 ha (48.8 ac) in the low, 184.8 ha (456.6 ac) in the very low, and only 0.02 ha (0.06 ac) in the high fire risk area. The critical habitat in the action area, together with 224 ha (554 ac) outside the action area, was designated to provide habitat for the conservation of five populations of *C. herbstii*. Each population should be represented with a minimum of 300 mature individuals in order to attain recovery goals for this species (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, shaded gulch bottoms and slopes in mesic *Acacia koa-Metrosideros polymorpha* (koa-ohia) lowland forests or diverse mesic forests. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within mesic koa-ohia lowland forests or diverse mesic forests. It is estimated that only 30 percent of the critical habitat is in an area of greater than 75 percent native plant cover (K. Kawelo, pers. comm. 2004; 68 FR 35950). This indicates that this unit has been impacted by the encroachment of non-native plants. In the absence of habitat management, fires from military actions could add to the ongoing degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

There is a risk that if a fire started in the impact area, it could move east and impact this unit or that a misfired round could ignite outside of the firebreak road and burn into this unit. However, this risk is reduced due to the beneficial resource management actions conducted by the Army in the management units, the low flammability of the surrounding vegetation (mesic forest), and spatial separation from the impact area. Eighty-five percent of this critical habitat unit that lies in the Makua action area is located in Kahanahaiki, Pahole, Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha management units.

Please see *Schiedea obovata* for a more detailed discussion on the beneficial Army actions in the aforementioned management units. All of these conservation actions being conducted or planned for implementation in these management units will enhance the conservation value of the critical habitat for *Chamaesyce herbstii*. The remaining critical habitat (31 ha; 77 ac) outside of the management units is separated from the impact area by the management units themselves. The fuel modification activities plus other conservation measures implemented by the Army for species stabilization will further reduce the risk of fire to the portion of the critical habitat outside of the management unit.

<u>Conclusion</u>

The critical habitat unit for *Chamaesyce herbstii* in the Makua action area is located mostly within the low fire risk area. Less than one percent of the unit is in the high fire-risk zone. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit. In addition, fuel reduction within the management units will further buffer the critical habitat unit from fire. The portions of critical habitat that is within Kahanahaiki, Pahole, Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha management units will be managed to improve their baseline quality pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *C. herbstii* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. herbstii* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *C. herbstii*.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Kaena East of Alau
Haili to Kealia
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Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
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Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 29
Chamaesyce herbstii
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
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UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Cyanea grimesiana* ssp. *obatae* (Haha)

Cyanea grimesiana ssp. *obatae* is a short-lived perennial with approximately 254 total individuals in existence range-wide. There are an estimated 42 individuals in the action area located in Pahole (16 individuals) and West Makaleha (26 individuals) management units (Figure E 30). The population unit in the action area has not met stabilization goals (defined as 100 mature, reproducing individuals) since threats are not controlled, and numbers are currently being maintained primarily through augmentation. Currently, the action area contains about 16 percent of all remaining *C. grimesiana* ssp. *obatae* individuals. *C. grimesiana* ssp. *obatae* has a high background risk of extinction due to its very low numbers, low vigor, and extreme susceptibility to rat and slug predation. *C. grimesiana* ssp. *obatae* was identified as an expedited stabilization species as a conservation measure to protect these taxa from jeopardy while full stabilization measures are being implemented over the long term.

<u>Analysis of Effects of the Proposed Action</u>

Over the next 30 years, *Cyanea grimesiana* ssp. *obatae* individuals in the Pahole to West Makaleha population unit will be exposed to direct and indirect effects of training-related wildland fire in the low and very low fire risk zones. As an understory shrub, all individuals and life stages are vulnerable to the risk of high and low severity wildland fires that will result in injury and death. All *C. grimesiana* ssp. *obatae* plants growing in the low and very low fire risk area in the Pahole Management Unit may be impacted by spot fires spawned by intense fires burning in Makua Valley, or by fires ignited by a misfired long-range, live-fire weapon such as the TOW. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac) (see General Effects - Fire Suppression). The individuals in the West Makaleha Management Unit are almost 3.2 km (1.9 mi) from the training impact area and are buffered by the steep western cliffs of Ohikilolo Ridge. These individuals are at a very low risk of impact from training-related wildland fires.

In addition, reaching expedited stabilization goals (see Expedited Group Effects) prior to the use of incendiary weapons from Column C (see Table PD 2) will offset the risk of extinction while full stabilization measures are being implemented. Expedited stabilization improves the likelihood that *Cyanea. grimesiana* ssp. *obatae* will attain full stabilization and enhance its probability of persistence over the long term. No long-range weaponry will be used until expedited stabilization thresholds are achieved in all stabilization population units (see Expedited Group Effects).

<u>Other Risk Reduction Factors</u>

In addition to wildland fire, *Cyanea grimesiana* ssp. *obatae* will also be exposed to the direct and indirect impacts of non-native plants, slugs, rats, and ungulates. Slug damage is particularly threatening to the survival and recovery of this species (see Status and Baseline section) because no feasible control methods are available for field situations. The direct and indirect effects of non-native weeds and invertebrates will reduce the vigor, reproduction, recruitment, and survival of individual plants. The Army Natural Resources Staff are working to develop slug control techniques to address predation of *Cyanea* species in Makua (U.S. Army Garrison 2006c). Full stabilization will require development of slug control techniques to increase survival and recruitment.

The Pahole portion of the Pahole to West Makaleha population unit is within the fenced Pahole Management Unit, and the West Makaleha portion is protected by a small ungulate exclosure and rat control grid. The population unit is partially controlled for weeds. The Army will add a fourth stabilization population unit in the Makaha Management Unit (K. Kawelo, Makua Implementation Team meetings 2007). Expedited stabilization will involve continued augmentation of *C. grimesiana* ssp. *obatae* in the Pahole to West Makaleha population unit inside the action area. Outside the action area, the Central Kaluaa and Palikea (South Palawai) population units will continue to receive extensive augmentation. *Cyanea grimesiana* ssp. *obatae* is successfully propagated from seed, which generally can be collected throughout the year. In 2005, supplemental plantings were conducted at existing reintroduction sites adding a total of 36 plants. A year later the Army Natural Resources Staff noted that approximately 75 percent of the reintroduced plants in the Waianae Mountains was still present (U.S. Army Garrison, 2006c). Small plants require a shorter growing time in the nursery, are easier to transport, and can be planted in more locations such as steep slopes where wild plants are known to occur.

The entire current range of *Cyanea grimesiana* ssp. *obatae* occurs on non-Army controlled lands. The Pahole to West Makaleha population unit in the action area is located on State lands, where Army implementation of stabilization actions will be covered by a long-term cooperative agreement. The Central Kaluaa and Palikea population units are located in Honoluliuli Preserve.

<u>Conclusion</u>

Despite the ongoing exposure of *Cyanea grimesiana* ssp. *obatae* to project wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, expedited and eventually full stabilization actions over the next 30 years will increase population numbers of *C. grimesiana* ssp. *obatae* in four population units, including two outside the action area that will not be vulnerable to training-related wildland fire. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *C. grimesiana* ssp. *obatae* in and adjacent to the action area. Reaching expedited stabilization will improve the likelihood that *C. grimesiana* ssp. *obatae* will attain full stabilization and enhance its probability of persistence over the long term. Therefore, based on our analysis of the effects of the actions outlined in the Project Description, including training-related fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

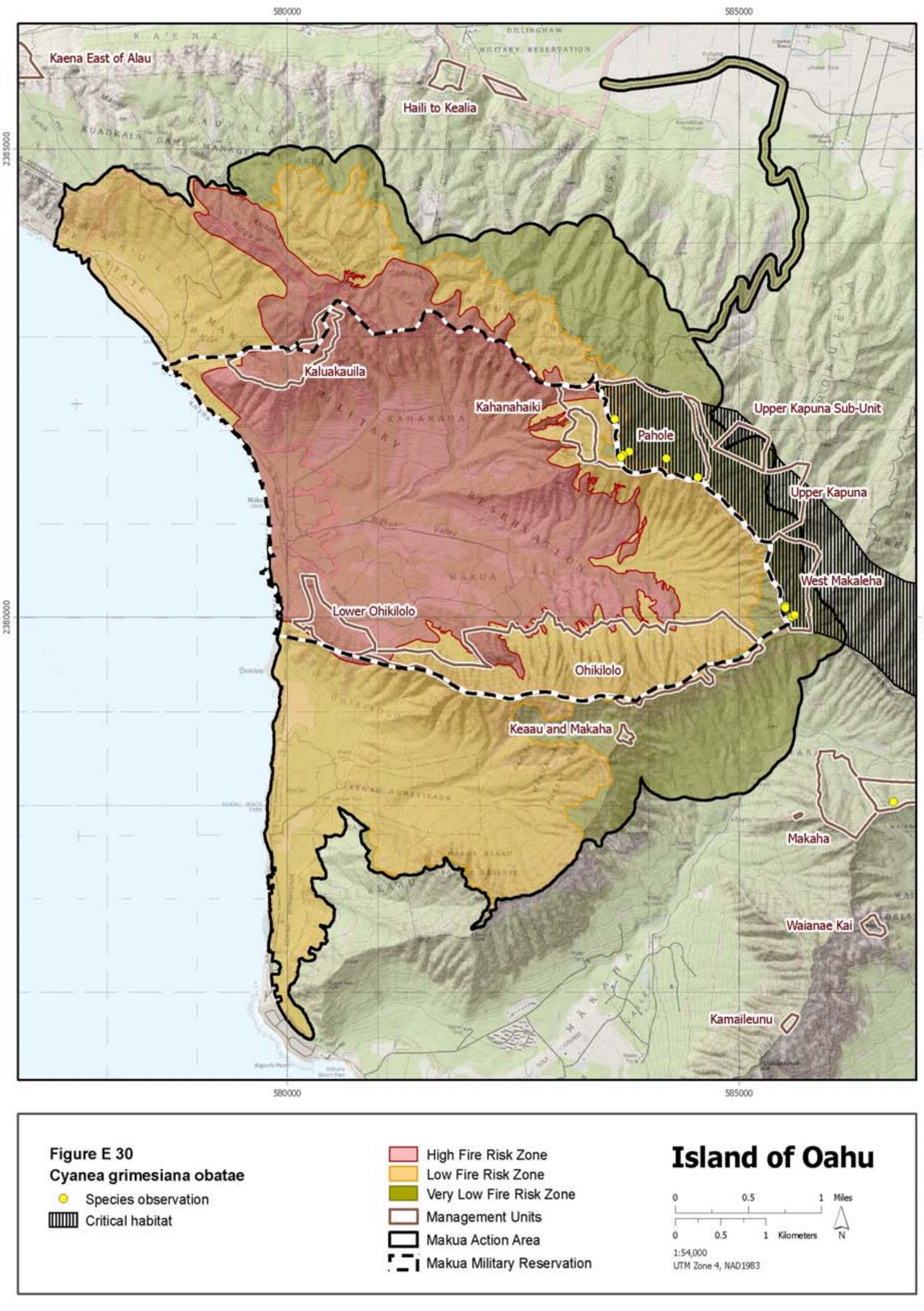
Effects of the Action on *Cyanea grimesiana* ssp. *obatae* Critical Habitat

The critical habitat unit within the Makua action area for *Cyanea grimesiana* ssp. *obatae* encompasses 25 percent (209 ha; 512 ac) of the designated critical habitat for this species (see Figure E 30). It is located in the northeastern portion of the action area and is almost entirely within only the very low fire zone 192.7 ha (476.2 ac). The critical habitat unit (area inside and outside of the action area) provides habitat for the conservation of three populations, each comprised of 300 reproducing individuals of *C. grimesiana* ssp. *obatae* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, steep, moist, shaded slopes in diverse mesic to wet lowland forests. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within diverse mesic to wet lowland forests. It is estimated that more than 50 percent of the critical habitat is in an area with greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004). This indicates some encroachment of non-native plants into this unit. In the absence of resource management, fires from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

The risk of a training-related fire to this unit is reduced due to the beneficial resource management actions conducted by the Army in the management units, in combination with the low flammability of the surrounding vegetation (mesic and wet forests), and spatial separation from the impact area. Eighty-eight percent (247 ha; 610 ac) of the critical habitat unit is located in several management units (Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, West Makaleha). These management units and the beneficial actions implemented by the Army are discussed in detail in the effects section for *Schiedea obovata*. The remaining critical habitat (35 ha; 86 ac) for this species located outside of the management units is buffered from the impact area by the management units themselves. The fuel modification activities, plus other conservation measures implemented by the Army for species stabilization, will further reduce the risk of fire to the portion of the critical habitat outside of the management units.

Conclusion

The critical habitat unit for *Cyanea grimesiana* ssp. *obatae* in the Makua action area is almost entirely within the low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire to the critical habitat will be reduced due to the low flammability of the surrounding mesic forests, the spatial separation from the impact area, and the beneficial resource management actions conducted by the Army. Fuel reduction within the management units will buffer the critical habitat unit from fire. The critical habitat that is within the Central and East Makaleha, Upper Kapuna Sub-Unit, Pahole, Upper Kapuna, and West Makaleha management units will be managed to improve its baseline quality pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *C. grimesiana* ssp. *obatae* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. grimesiana* ssp. *obatae* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *C. grimesiana* ssp. *obatae*.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Pahole
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Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 30
Cyanea grimesiana obatae
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Cyanea longiflora* (Haha)

The range-wide status of *Cyanea longiflora* is now limited to 171 total individuals in three population units (Figure E 31). In the action area there are an estimated 158 individuals in Upper Kapuna to West Makaleha (56) and Pahole (102) population units. *C. longiflora* in the action area represents 92 percent of the total individuals and is characterized by two population units defined as 75 mature, reproducing individuals.

Cyanea longiflora has been identified as particularly at risk in the action area, based primarily on their overall status, environmental baseline within the action area, and exposure to training-related wildland fires. Because of these factors, it is likely *C. longiflora* is already is in a phase of quasi-extinction with numbers that have declined to the point where demographic or environmental stochasticity alone can result in extirpation (see General Effects – Small Population Size). We infer from these circumstances, conservation biology principles, and examples from other species that *C. longiflora* has a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence. Therefore, *C. longiflora* was identified as an expedited stabilization species as a conservation measure to protect this taxon from jeopardy while full stabilization measures are being implemented over the long-term.

<u>Analysis for Effects of the Proposed Action</u>

Over the next 30 years, *Cyanea longiflora* individuals in the Kapuna to West Makaleha and Pahole population units will be exposed to the direct and indirect effects of training-related wildland fire in the low and very low fire risk zones. As an understory shrub, all individuals and life stages are vulnerable to the risk of high and low severity wildland fires. The proposed action will result in injury and death of *C. longiflora* individuals in the action area as a result of training-related wildland fire. About 56 individuals occur in the low fire risk zone and 102 in the very low fire risk zone. All *C. longiflora* plants growing in the low and very low fire risk area in the Pahole Management Unit may be impacted by spot fires spawned by intense fires burning in Makua Valley, or by fires ignited by a misfired long-range, live-fire weapon such as the TOW. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac) (see General Effects - Fire Suppression). The individuals in the West Makaleha Management Unit are almost 3.2 km (1.9 mi) from the training impact area and are buffered by the steep western cliffs of Ohikilolo Ridge. Mesic forest conditions generally protect *C. longiflora* from the spread of fire, therefore, these individuals are at a very low risk of impact from training-related wildland fires.

Because the action area contains about 92 percent of all remaining individuals, the environmental baseline of *Cyanea longiflora* in the action area is virtually equivalent to the status of the species as a whole. This species is characterized by fluctuating numbers, a trend of local decline, distribution in three unstable population units, limited recruitment, and low numbers that are increasing primarily due to augmentation. To offset the risk of extirpation due to training-related wildland fires, certain weapons systems and munitions will be restricted until fire protection fuelbreaks are in place and expedited stabilization thresholds are achieved (see General Effects –

Fire Suppression). No long-range weaponry will be used until expedited stabilization goals are met for all stabilization population units. In the action area, expedited stabilization actions will involve continued augmentation of *C. longiflora* in the Makua population unit and reintroduction in the Kaluakauila population unit. Outside the action area, the Makaha and Waianae Kai population unit will contain plants that are not exposed to the threat of training-related fires. Three population units will be managed as stabilization population units in order to represent the full, genetic, geographical and morphological complement of this species.

The direct and indirect effects of non-native weeds, invertebrates, and ungulates will reduce the vigor, reproduction, recruitment, and survival of individual plants. *Cyanea longiflora* in the action area also will be exposed to the direct and indirect impacts of non-native plants, slugs, and ungulates. *C. longiflora* is particularly susceptible to slug damage and the Army is sponsoring ongoing research to determine a methodology to control slugs (U.S. Army Garrison 2006c).

<u>Other Risk Reduction Factors</u>

The Pahole population unit in the action area is within the fenced Pahole management unit. Reintroduced plants in the West Makaleha portion of the Kapuna to West Makaleha population unit in the action area are within a small fenced exclosure. Both population units are partially controlled for weeds. In 2005, Natural Resources Staff outplanted 23 immature *Cyanea longiflora* to augment the Kapuna to West Makaleha population unit and in 2006, 20 were still alive (U.S. Army Garrison 2006c). Outside the action area, the Makaha and Waianae Kai population unit also will continue to receive extensive augmentation. *Cyanea longiflora* can be successfully propagated from seed; larger plants survive better when outplanted in the wild than small plants.

<u>Conclusion</u>

Despite the ongoing exposure of *Cyanea longiflora* to training impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will increase baseline numbers of *C. longiflora* to stability thresholds. However, the risk of training-related wildland fire to plants (158 individuals) within the action area is low or very low and the action area population units are located in manageable habitat where ungulate and weed threats can be controlled. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *C. longiflora* in and adjacent to the action area over the next 30 years. Reaching expedited stabilization will improve the likelihood that *C. longiflora* will attain full stabilization and enhance its probability of persistence over the long term.

Effects of Action on *Cyanea longiflora* Critical Habitat

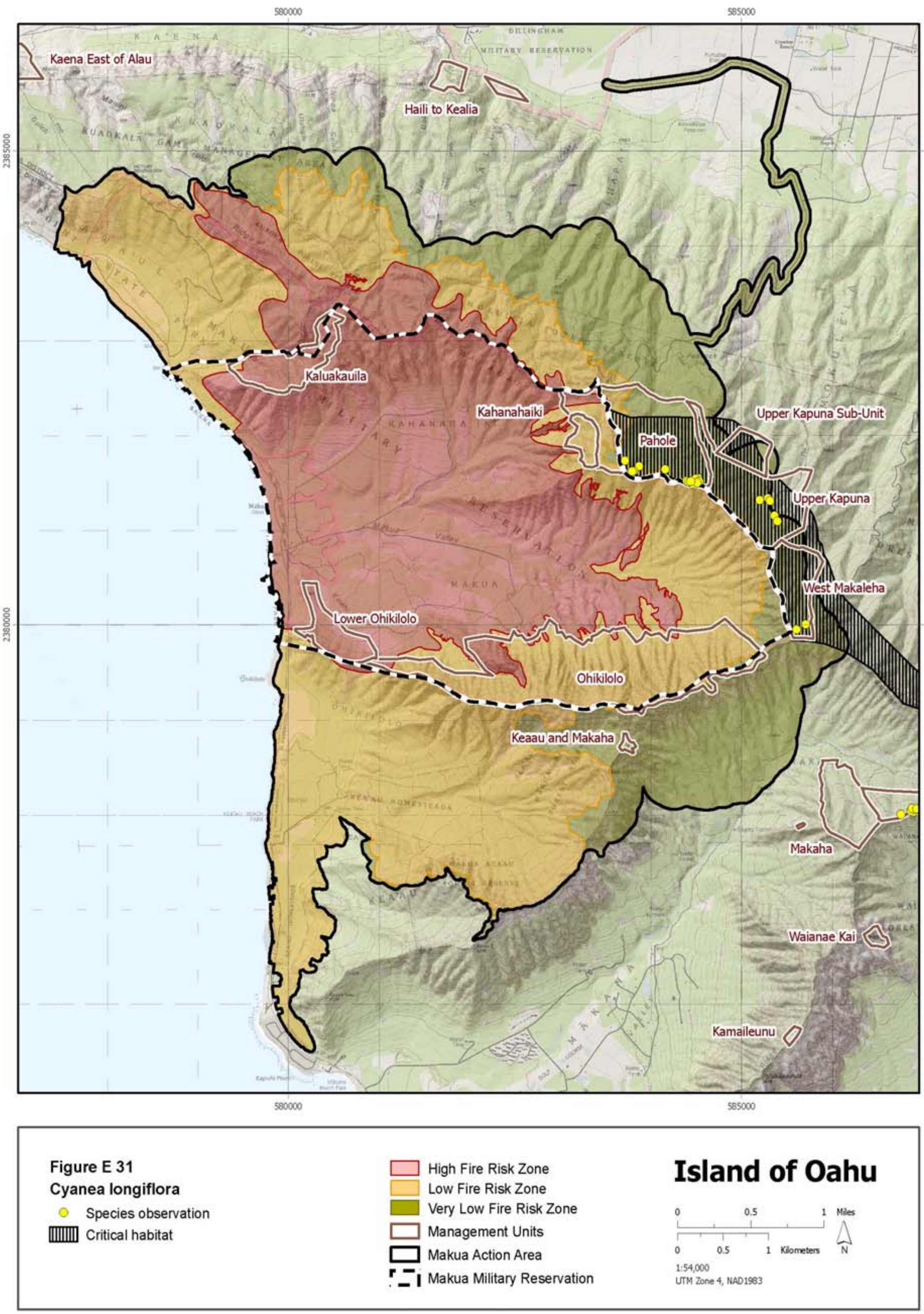
Approximately 177 ha (437 ac), or 24 percent of the total designated critical habitat for *Cyanea longiflora*, is located in the Makua action area (see Figure E 31). The unit is located in the northeastern portion of the action area and is entirely within the low fire zones, with 9.2 ha (22.6

ac) in the low fire risk zone and 167.9 ha (414.8 ac) in the very low zone. This critical habitat unit, together with 185 ha (458 ac) outside of the action area, was designated to provide habitat for the conservation of four populations. Each population is to be represented by at least 300 mature, reproducing individuals of *C. longiflora* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, steep slopes, bases of cliffs, or ridge crests in mesic *Acacia koa-Metrosideros polymorpha* (koa-ohia) lowland forest. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within mesic koa-ohia lowland forest. Almost one-half of the critical habitat is located in an area with 50 to 75 percent native plant cover, and the remainder is in an area that is composed of almost entirely native plant vegetation (U.S. Army Garrison 2003b; L. Durand, pers. comm. 2004; K. Kawelo, pers. comm. 2004; 68 FR 35950). This indicates that these critical habitat units are composed of a high proportion of native plant species. However, in the absence of habitat management, fires could add to the degradation of these critical habitat units by removing the remaining native habitat.

There is a risk that if a fire started in the impact area, it could move east and impact this critical habitat unit or that a misfired round could ignite outside of the firebreak road and burn into this unit. The loss of primary constituent elements within critical habitat unit, together with the 185 ha (458 ac) outside the action area, would remove its ability to provide for the conservation of four populations of *Cyanea longiflora*. However, this risk is reduced by spatial separation from the impact area, low flammability of the surrounding vegetation (mesic forest), and the beneficial resource management actions conducted by the Army in the management units. Approximately 153 ha (378 ac), or 86 percent, of the total critical habitat is located in management units (Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, West Makaleha management units). Please see the discussion for *Schiedea obovata* regarding management units and the beneficial actions occurring within these areas. The remaining critical habitat (24 ha; 59 ac) outside of the management units is buffered from the impact area by the management units themselves. The fuel modification activities and the other threat reduction measures implemented by the Army for species stabilization will further reduce the risk of fire to the critical habitat outside of the management units.

Conclusion

The critical habitat unit for *Cyanea longiflora* in the Makua action area is located entirely in the low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire in the critical habitat unit will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management unit that is adjacent to the critical habitat, and the Central and East Makaleha Management Unit. Fuel reduction within the surrounding management units (Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, and West Makaleha) will further buffer the critical habitat unit from fire. Without this management, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *C. longiflora* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. longiflora* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *C. longiflora*.



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Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 31
Cyanea longiflora
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
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0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Cyanea superba* ssp. *superba* (No Common Name)

The range-wide status of *Cyanea superba* ssp. *superba* is now limited to approximately 310 individuals. *Cyanea superba* ssp. *superba* was extirpated from the wild in 2002, and all extant plants were reintroduced from greenhouse stock. Approximately 50 percent of all remaining *C. superba* ssp. *superba* individuals in the Makua action area are located in the Kahanahaiki Population Unit (Figure E 32). After full stabilization, there will be four population units for this species with 50 mature, reproducing individuals.

This subspecies is characterized by a recent history of precipitous decline in the number of individuals, extremely low genetic variability, and extirpation of all naturally occurring plants. Because of these factors, *C. superba* ssp. *superba* already is in a phase of quasi-extinction with numbers declined to the point where demographic or environmental stochasticity alone can result in extirpation (see General Effects – Small Population Size). We infer from these circumstances, conservation biology principles, and examples from other species that *C. superba* ssp. *superba* has a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence. Therefore, *C. superba* ssp. *superba* has been identified as an at risk species based on its limited population status, restricted distribution, high percentage of individuals in the action area, and risk of training-related wildland fire. *Cyanea superba* ssp. *superba* was identified as an expedited stabilization species as a conservation measure to protect these taxa from extirpation while full stabilization measures are being implemented.

<u>Species Response to the Proposed Action</u>

Over the next 30 years, *Cyanea superba* ssp. *superba* individuals in the Kahanahaiki, Pahole and Upper Kapuna management units (see Figure E 32) will be exposed to the direct and indirect effects of training-related wildland fire in the low and very low fire risk zones. Out of the 310 individuals in the action area approximately 55 to 60 are at a greater risk of impact from a training related wildland fire due to their proximity to previously burned habitat. These 60 plants are located between 140 and 200 m (460 and 656 ft) from the high fire risk area where the historic intrusion of invasive, flammable fuels, increases the risk of a future fire in this area. To offset this risk, the Army will construct either a 20-m (65-ft) wide firebreak, or a 200-m (656-ft) wide shaded fuelbreak in Kahanahaiki Gulch along the Kahanahaiki Management Unit perimeter. In addition, a helispot will be maintained within 500 m (1,640 ft) of the upper reaches of Kahanahaiki Gulch and a safety zone will be established within or adjacent to the management unit so that skilled NWCG-qualified fireline supervisors and firefighters, including red-carded Army Natural Resources Staff, can be safely stationed at the outplanting site when fire threatens the gulch area. These efforts are likely to result in the prevention of loss of *C. superba* ssp. *superba* individuals in the Kahanahaiki Gulch area.

Cyanea superba ssp. *superba* individuals in the Kahanahaiki Management Unit (approximately 120) are also in the low risk area, but due to their more protected location; i.e., further away from the edge of the high fire area, these individuals are at a reduced risk of impact from fire. We estimate that a misfired weapon landing in forest and shrub areas will burn approximately 0.1 ha (0.3 ac) of forest prior to fire suppression measures extinguishing the fire. Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period. However, to avoid the risk of an undetected fire, the Army will conduct an aerial survey in a helicopter for 1-hour post-training to check for smoke from a misfired round (see General Effects - Fire Suppression).

The remainder of the *Cyanea superba* ssp. *superba* individuals (approximately 130) are located in and adjacent to the Pahole and Upper Kapuna management units in the very low fire risk zone. These plants could be susceptible to a misfired long-range, live-fire weapon such as the TOW. However, as with our determination for the risk of fire in the low risk area, fire detection and suppression response is designed to minimize a fire ignited in mesic forest and shrub areas.

<u>Other Risk Reduction Factors</u>

Cyanea superba ssp. *superba* in the action area also will be exposed to the direct and indirect impacts of non-native plants, slugs, and rats. Slug damage is particularly threatening to the survival and recovery of this species because no feasible control methods are available for field situations. The Kahanahaiki Population Unit is within the fenced Kahanahaiki Management Unit and is regularly controlled for weeds and rats. Certain weapons systems and munitions will be restricted until a fire protection system is in place for the Kahanahaiki Management Unit and expedited stabilization thresholds are achieved for at-risk taxa that occur in that management unit. Expedited stabilization will involve continued augmentation of *C. superba* ssp. *superba* in the Kahanahaiki Population Unit inside the action area. Three additional population units will be established by reintroduction in the Central and East Makaleha, Makaha, and Pahole to Kapuna population units outside the action area. Four population units will be managed for stability for this taxon because all naturally occurring plants have died, and because stabilization must be achieved solely through reintroduction. *Cyanea superba* ssp. *superba* is successfully propagated from seed; outplants grow vigorously and produce ample viable seed. Full stabilization will depend on developing slug control techniques to increase survival and recruitment.

<u>Conclusion</u>

Despite the ongoing exposure of *Cyanea superba* ssp. *superba* to Army-related wildland fires, fire risk to this species is low to very low, and Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. In this case, *C. superba* ssp. *superba* would be extinct in the wild without the stabilization efforts conducted by the Army's Natural Resources Staff. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited and full stabilization actions over the next 30 years will increase *C. superba* ssp. *superba* distribution and abundance. The minimal risk of wildland fire is far outweighed by the benefit of stabilization to this species. We further believe this species is unlikely to survive without the Army's expedited and full stabilization efforts.

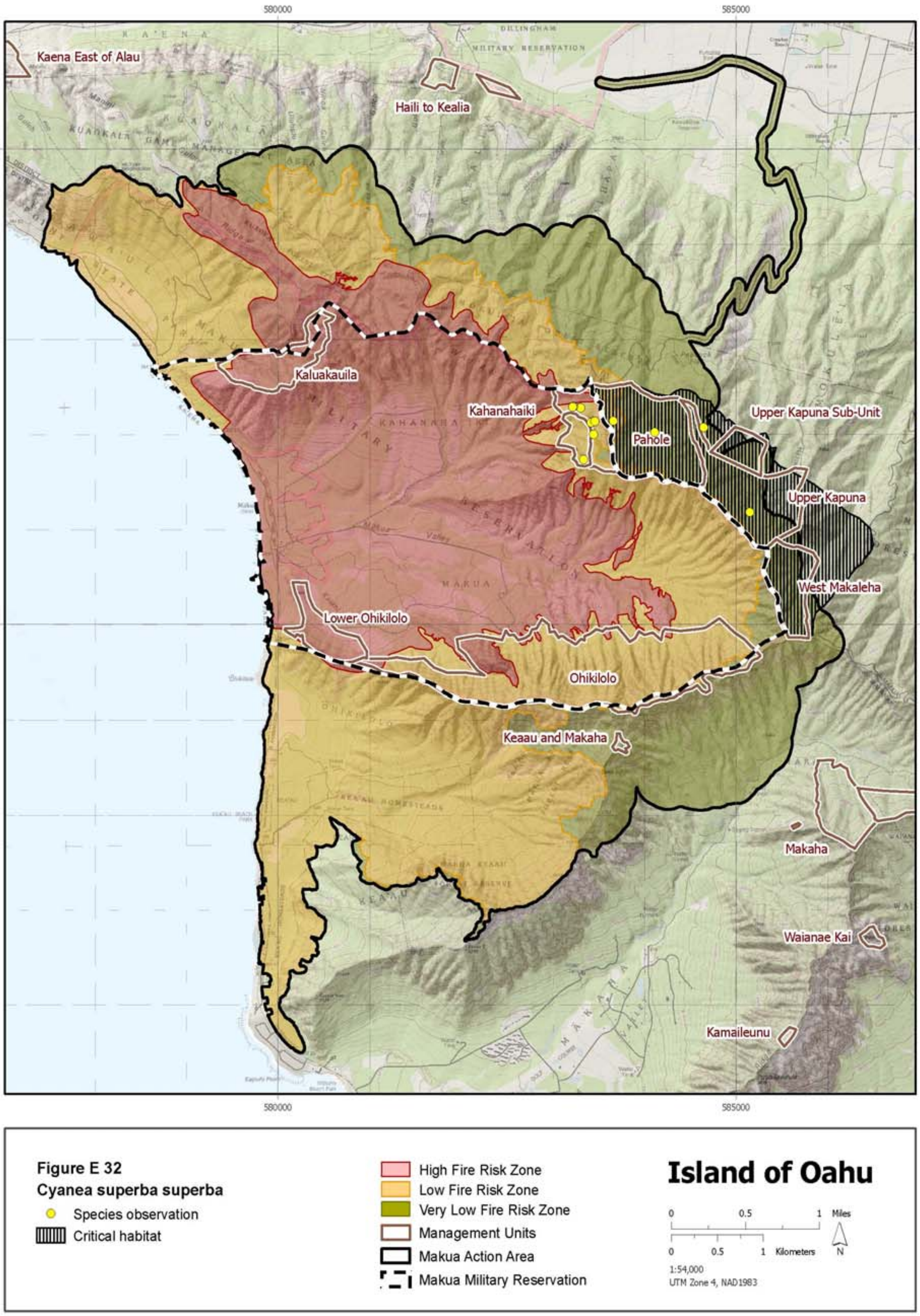
Effects of the Action on *Cyanea superba* ssp. *superba* Critical Habitat

Twenty-three percent (207 ha; 511 ac) of the State-wide critical habitat for *Cyanea superba* ssp. *superba* is located within the Makua action area. Over 99.9 percent of this critical habitat unit is within the low fire zones, with 17 ha (42.3 ac) in the low fire risk zone and 189.3 ha (467.7 ac) in the very low zone in the northeastern portion of the action area (see Figure E 32). This critical habitat, together with 96 ha (237 ac) outside the action area, was designated to provide habitat for the conservation of four populations, each consisting of 300 mature individuals of *C. superba* ssp. *superba* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, sloping terrain on a well-drained rocky substrate within mesic forest (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include the associated native plant species found within a mesic forest community on Oahu. It is estimated that more than one-half of the critical habitat still contains greater than 50 percent native plant cover, indicating that habitat quality is somewhat compromised due to non-native plant encroachment (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004; 68 FR 35950). Fire removes the vegetative primary constituent elements and non-native plants invasives subsequently outcompete native plants, which prevents post-burn native re-vegetation. In the absence of habitat management, these areas remain degraded and future fires will incrementally encroach into unburned areas, continuing the process of removing vegetative primary constituent elements.

Approximately 88 percent (182 ha; 451 ac) of the critical habitat in the action area is found within the Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, West Makaleha management units. Please see the effects section for *Schiedea obovata* for a more detailed discussion of the effects of the proposed action on this critical habitat unit. The remaining critical habitat for *Cyanea superba* ssp. *superba* outside of the management units (25 ha; approx. 59 ac) is separated from the impact area by low fire risk areas and by the management units themselves.

<u>Conclusion</u>

The critical habitat unit for *Cyanea superba* ssp. *superba* in the Makua action area is located almost entirely within the low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of fuel modification zones between the impact area and their respective management units. In addition, due to the fuel reduction and other habitat enhancing activities currently ongoing and planned, pursuant to the Makua Implementation Plan, the Kahanahaiki Management Unit will buffer portions of the critical habitat from fires traveling from the impact zone. The critical habitat within the Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, West Makaleha management units will be managed to improve baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *C. superba* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. superba* ssp. *superba* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *C. superba* ssp. *superba.*



580000
585000
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Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 32
Cyanea superba superba
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Delissea subcordata* (no Common Name)

Delissea subcordata, an Oahu perennial endemic, has an estimated range-wide population of approximately 185 individuals. There are roughly 22 mature *D. subcordata* individuals in the action area (Figure E 33), but threats are not controlled and numbers are maintained primarily through augmentation. Today the action area contains only about 12 percent of all remaining *D. subcordata* individuals; however, in 2006, when the Service and the Army agreed on expedited stabilization for at-risk taxa, the action area contained about 17 percent of all remaining individual. Although these numbers do not fit the general criteria used to identify at-risk taxa, the Army agreed to include *D. subcordata* in expedited stabilization activities due to this species' critically endangered status and its risk of fire from military training at both Makua and Schofield Barracks Military Reservation.

<u>Species Response to the Proposed Action</u>

The majority of the remaining *Delissea subcordata* in the action area are located in the Kahanahaiki to Keawapilau population unit where Army training with long-range, incendiary weapons could result in injury and death of *D. subcordata* individuals. The population most at-risk are the 17 individuals located along the perimeter of the Kahanahaiki Management Unit only 330 m (1083 ft) from the edge of the high fire risk area. The close proximity of these plants to this historically burned area increases the risk that a future fire will spread quickly through the disturbed vegetation and encroach further into the forest edge. To minimize the risk of fires in Kahanahaiki Gulch (west of the occupied management units), the Army will construct either a 20-m (65-ft) wide firebreak, or a 200-m (656-ft) wide shaded fuelbreak in Kahanahaiki Gulch along the Kahanahaiki Management Unit perimeter. In addition, a helispot will be maintained within 500 m (1,640 ft) of the upper reaches of Kahanahaiki Gulch and a safety zone will be established within or adjacent to the management unit. These additional minimization measures will help preserve the extant individuals of *D. subcordata*.

A few individuals of *Delissea subcordata* are located in the Upper Kapuna Management Unit that coincides with the very low fire risk area. We estimate that a misfired live-fire weapon landing in forest and shrub areas will burn approximately 0.1 ha (0.3 ac) of forest prior to fire suppression measures extinguishing the fire. Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period. However, to avoid the risk of an undetected fire, the Army will conduct an aerial survey in a helicopter for 1-hour post-training to check for smoke from a misfired round (see General Effects - Fire Suppression).

<u>Other Risk Reduction Factors</u>

Certain weapons systems and munitions will be restricted until a fire protection system is in place for the Kahanahaiki Management Unit and expedited stabilization thresholds are achieved for at-risk taxa that occur in that management unit (see Table PD 2). Expedited stabilization will involve continued augmentation of *D. subcordata* in the action area and outside the action area (Ekahanui, Kaluaa, and Palawai population units).

A portion of the Kahanahaiki to Keawapilau population unit is within the fenced Kahanahaiki Management Unit and the entire population unit is partially controlled for weeds. *Delissea subcordata* in the action area also will be exposed to the direct and indirect impacts of non-native plants, slugs, and rats. Slug damage is particularly threatening to the survival and recovery of this species and the Army has sponsored further research on this problem. The direct and indirect effects of non-native weeds and invertebrates will reduce the vigor, reproduction, recruitment, and survival of individual plants. However, augmentation conducted by the Army Natural Resources Staff is probably one of the main reasons this plant is still extant in the wild (U.S. Army Garrison, 2006). *Delissea subcordata* is successfully propagated from seed, and as of 2005, survival of outplantings was estimated at 70 percent. Overall, four population units will be managed for stability for this taxon because it occurs in both the Makua and Schofield Barracks action areas. However, full stabilization of this species will be dependent on developing slug control techniques to increase survival and recruitment.

<u>Conclusion</u>

This species is characterized by low numbers and large fluctuations, local declines of naturally occurring individuals, limited recruitment, and predation by slugs and rats and can be characterized by a very high background risk of extinction. However, there is an overall increase in the numbers of *Delissea subcordata* due to reintroduction and augmentation (see Species Status and Baseline). Despite the ongoing exposure of *D. subcordata* to training-related wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, expedited and full stabilization actions over the next 30 years will increase the distribution and abundance of *D. subcordata.* Four population units, including three outside the action area that are not vulnerable to training-related wildland fires, will be stabilized over the long term. Achieving the criteria for expedited stabilization will improve the likelihood that *D. subcordata* will attain full stabilization and enhance this species probability of persistence over the long-term.

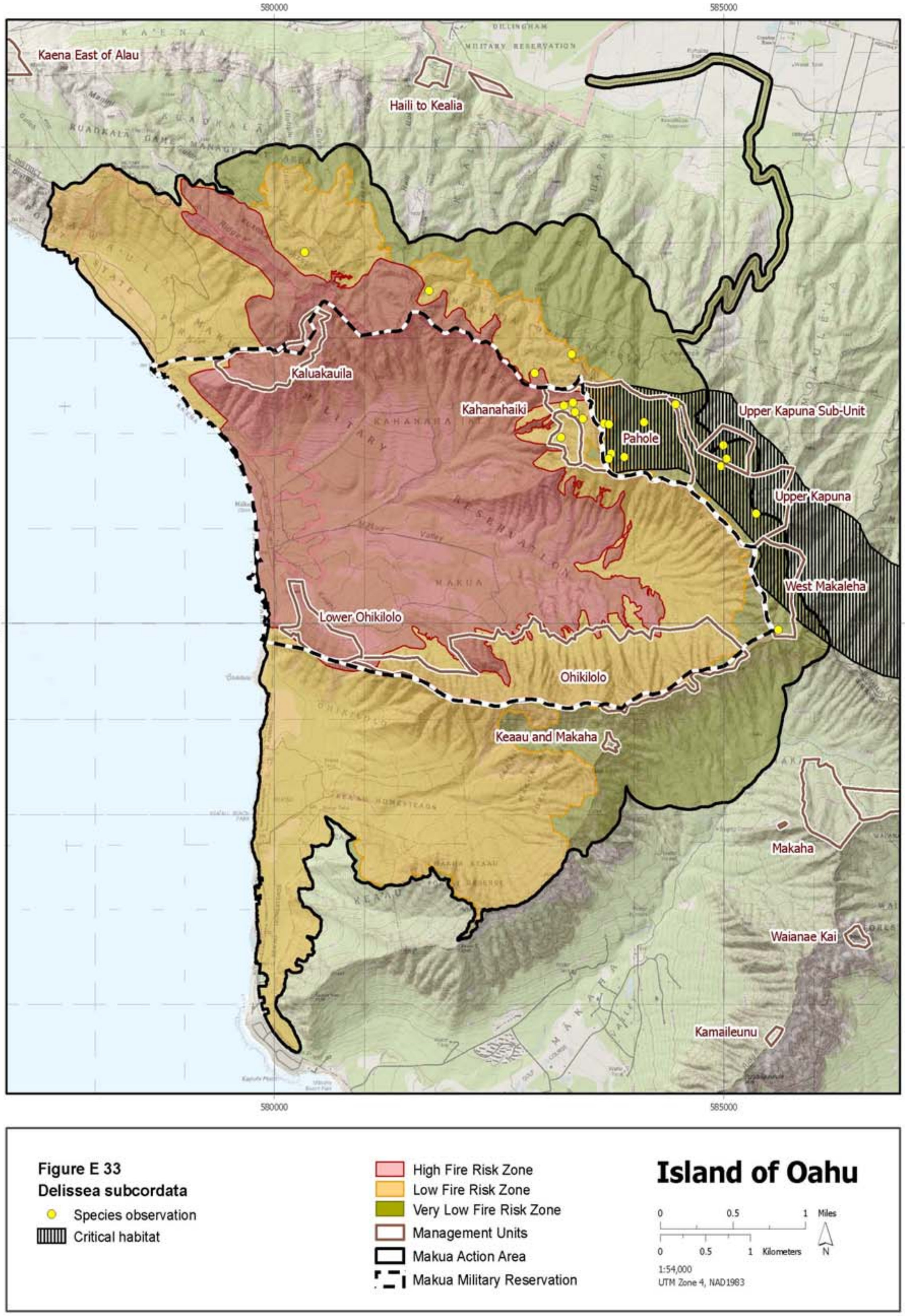
Effects of the Action on *Delissea subcordata* Critical Habitat

Twelve percent (187 ha; 462 ac) of the critical habitat for *Delissea subcordata* is located in one unit within the Makua action area. The vast majority of the critical habitat is located in the low fire zones, with 13.03 ha (32.19 ac) in the low fire risk zone and 173.49 ha (428.71 ac) in the very low zone in the northeastern portion of the action area (see Figure E 33). This portion of the critical habitat, together with 577 ha (1,425 ac) outside the action area, was designated to provide habitat for the conservation of four populations, each with a minimum of 300 reproducing individuals of *D. subcordata* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, moderate to steep gulch slopes in mixed mesic forest (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a mixed mesic forest community on Oahu. It is estimated that more than one-half of the critical habitat is located in forest habitat with greater than 50 percent native plant cover, indicating some habitat degradation has occurred (K. Kawelo, pers. comm. 2004).

Approximately 84 percent (156 ha; 385 ac) of the critical habitat in the action area is found within management units (Kahanahaiki, Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, West Makaleha). Due to locations and similarities of potential effects from training, please see the discussion for *Schiedea obovata*. The remaining critical habitat outside the management units (31 ha; approx. 77 ac) is separated from the impact area by low fire risk areas and by the above-mentioned management units themselves.

Conclusion

The critical habitat unit for *Delissea subcordata* in the Makua action area is almost entirely within the low fire risk area. Only 0.24 ha (0.6 ac), or less than one percent, is within the high fire risk area, and this portion is entirely within management units. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit. In addition, fuel reduction within the management units will further buffer the critical habitat from fire. The critical habitat within Pahole, West, East and Central Makaleha, and Upper Kapuna and Upper Kapuna Sub-Unit management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *D. subcordata* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *D. subcordata* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *D. subcordata*.



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Upper Kapuna Sub-Unit
Upper Kapuna
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Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
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Figure E 33
Delissea subcordata
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
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1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Gouania vitifolia* (No Common Name)

The range-wide status of *Gouania vitifolia* is now limited to about 81 total individuals, including 79 individuals on Oahu and only two known individuals on the island of Hawaii. The action area contains 77 individuals, or 95 percent of all remaining *Gouania vitifolia* range-wide (Figure E 34). Plants tend to occur in patches that likely consist of clones of a single or few individuals. Because of these factors, *G. vitifolia* already is in a phase of quasi-extinction with numbers that have declined to the point where demographic or environmental stochasticity alone can result in extirpation from the wild. We infer from these circumstances, conservation biology principles, and examples from other species that *G. vitifolia* has a very high background extinction, and any additional threats associated with training-related wildland fire could eliminate expectation of its long-term persistence. As a short-lived perennial, however, a stable population unit probably requires at least 50 mature, reproducing individuals. The Keaau population unit in the action area thus can be considered numerically stable, but threats are not controlled. *Gouania vitifolia* is an expedited stabilization species due to the low numbers and extreme risk of extinction.

<u>Species Response to the Proposed Action</u>

Over the next 30 years, *Gouania vitifolia* individuals in the Keaau population unit will be exposed to the direct and indirect effects of training-related wildland fire in the low fire risk zone. As a woody vine, all individuals and life stages are vulnerable to the risk of high and low severity wildland fires. The Keaau population unit of *Gouania vitifolia* is located on State-owned lands and currently this area is not fenced nor controlled for weeds. The surrounding dry habitat dominated by alien grasses facilitates the spread of fire. However, no long-range weaponry will be used until expedited stabilization thresholds are achieved for all stabilization population units. Expedited stabilization will involve fencing and maintenance of reduced grass fuel loads in the Keaau population unit inside the action area. Outside the action area, two other population units must be designated for stabilization, including habitat protection and augmentation of the Waianae Kai population unit; and establishment by reintroduction of a third population unit in an area to be identified by the Army and approved by the Service. Stabilization of *G. vitifolia* will depend on developing propagation and outplanting techniques for augmentation and reintroduction.

Despite the ongoing exposure of *Gouania vitifolia* to project wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will benefit the species and increase population numbers of *G. vitifolia*. Full stabilization includes three population units, with two units outside the action area that will not be vulnerable to training-related wildland fire. Thus, the overall effect of the proposed action’s stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *G. vitifolia* in and adjacent to the action area. Reaching expedited stabilization will improve the likelihood that *G. vitifolia* will attain full stabilization and enhance its probability of persistence over the long term.

Gouania vitifolia in the action area also will be exposed to the direct and indirect impacts of non-native ungulates and weeds, especially grasses. The direct and indirect effects of non-native weeds and invertebrates will reduce the vigor, reproduction, recruitment, and survival of individual plants. Habitat management measures such as fencing, weed control, and rat baiting will offset the detrimental effects of these stressors.

<u>Conclusion</u>

Despite the ongoing exposure of *Gouania vitifolia* to project wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, expedited and eventually full stabilization actions over the next 30 years will increase population numbers of *G. vitifolia* in three population units, including two outside the action area that will not be vulnerable to training-related wildland fire. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *G. vitifolia* in and adjacent to the action area. Reaching expedited stabilization will improve the likelihood that *G. vitifolia* will attain full stabilization and enhance its probability of persistence over the long term. Therefore, based on our analysis of the effects of the actions outlined in the Project Description, including training-related fire minimization measures, the Service concludes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Gouania vitifolia* Critical Habitat

There are four critical habitat units for *Gouania vitifolia* within the Makua action area. These four units represent three percent (84.2 ha; 208 ac) of the total State-wide critical habitat for this species. Three of the four units are located in the high fire risk area and were designated to provide habitat for the conservation of three populations of *G. vitifolia* (see Figure E 34). To meet recovery goals, each population of *G. vitifolia* would be comprised of at least 300 reproducing individuals of (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, sides of ridges or gulches in dry to mesic forests. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within dry to mesic forests. It is estimated that close to 90 percent of the critical habitat is located in areas with less than 25 percent native plant vegetation (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that these critical habitat units are degraded due to non-native plant encroachment. Critical habitat units A, B, and G are currently unoccupied. Unit H contains a population of this species. Units A and B, together, provide a portion of the habitat necessary for the establishment of an additional population of *G. vitifolia*, while unit G, alone, also provides a portion of habitat for the establishment of one population, in order to meet recovery goals for this species. Critical habitat unit H, in combination with the adjacent 42 ha (104 ac) of designated habitat outside the action area, provides habitat necessary for the expansion of the current population. Critical habitat unit B has been impacted by past fire events that have diminished the conservation value of this habitat. Fire removes the vegetative primary constituent elements. Non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

Critical habitat unit A (20 ha; 49 ac) is north of the Kaluakauila Management Unit (see Figure 25). This critical habitat unit is approximately 1.5 km (1 mi) from the impact area, and the risk of fire in this xeric grassland habitat is high. The surrounding vegetation is dominated by *Panicum maximum*, which is highly flammable and can increase the frequency and size of wildland fires (Beavers et al 1999). The 2003 prescribed burn encroached within 0.4 km (0.25 mi) of the critical habitat (G. Enriques, pers. comm. 2003).

Critical habitat unit B (0.01 ha; 0.02 ac) is within the Kaluakauila Management Unit and is approximately 1.2 km (0.7 mi) from the impact area. As described above, the risk of fire in this xeric grassland habitat is high. The 2003 prescribed burn impacted a portion of this critical habitat unit (G. Enriques, pers. comm. 2003). The consequence of this fire event is the encroachment of non-native grasses that provide flammable fuel and increase the potential for fires in the future. The loss of vegetative primary constituent elements within units A and B would remove their ability to provide a portion of the habitat necessary for one population of *Gouania vitifolia*. The Army will prepare a fire management plan for the Kaluakauila Management Unit and implement several fire abatement measures within and around this management unit (described above). These measures will help reduce the probability that critical habitat units A and B will burn. In addition, this management unit is currently fenced and fuel modification is being conducted to reduce the risk of fire in this area.

Critical habitat unit G (0.03 ha; 0.08 ac) is within the Lower Ohikilolo Management Unit and is approximately 0.3 km (0.2 mi) from the impact area. There is a high risk of fire in this xeric grassland habitat, and, in 2003 a prescribed burn impacted the lower portions of the management unit. Following the fire, the encroachment of non-native grasses provides more flammable fuel and increases the potential for fires in the future. The loss of vegetative primary constituent elements in this critical habitat unit would remove its ability to provide a portion of habitat for one population of *Gouania vitifolia*. Presently fuel modification is being conducted along the ridgeline between the management unit and the installation boundary to reduce the risk of fire in this area. The Army is reducing non-native plants in the Lower Ohikilolo Management Unit and controlling goats and pigs, pursuant to the Makua Implementation Plan. These actions will decrease the risk of fire within the management unit by reducing the fuel load in the area. In addition, a fuel management plan will be prepared and implemented to address fuel modification along the northern portion of this management unit. These actions will further reduce the risk of wildland fire from encroaching into the management unit.

Critical habitat unit H (22 ha; 54 ac) is in the southwestern portion of the Makua action area. This critical habitat is approximately 1.8 km (1 mi) from the impact area and the risk of fire in this xeric grassland habitat is high. The loss of the primary constituent elements of this unit would remove its ability, in combination with the adjacent 42 ha (104 ac) of designated habitat outside the action area, to provide habitat for one population of *Gouania vitifolia*. Critical habitat unit H does not overlap with a management unit. The critical habitat is separated from the impact area by the Lower Ohikilolo and Ohikilolo management units, which buffer it from fires ignited in the impact area. In both of these management units, the Army is working to reduce the amount of non-native plants, pursuant to the objectives in the Makua Implementation Plan. This action will decrease the risk of fire within the management units by reducing fuel load. In addition, a fuel management plan for the Lower Ohikilolo Management Unit will be prepared and implemented to address fuel modification for this management unit. These actions will further reduce the risk of wildland fire from encroaching into the management unit.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the revegetation process, the ability of these units to provide habitat essential for the conservation of three populations of *Gouania vitifolia* will be retained in the long-term.

Conclusion

Three of the four critical habitat units for *Gouania vitifolia* in the Makua action area are located in the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of fuel modification zones between the impact area and the Kaluakauila and Lower Ohikilolo management units. In addition, fuel reduction within the management units will further buffer the critical habitat from fire. The critical habitat that is within the Kaluakauila and Lower Ohikilolo management units will be managed to improve its baseline quality pursuant to the Makua Implementation Plan. Without this management, the critical habitat units would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *G. vitifolia* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *G. vitifolia* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *G. vitifolia*.

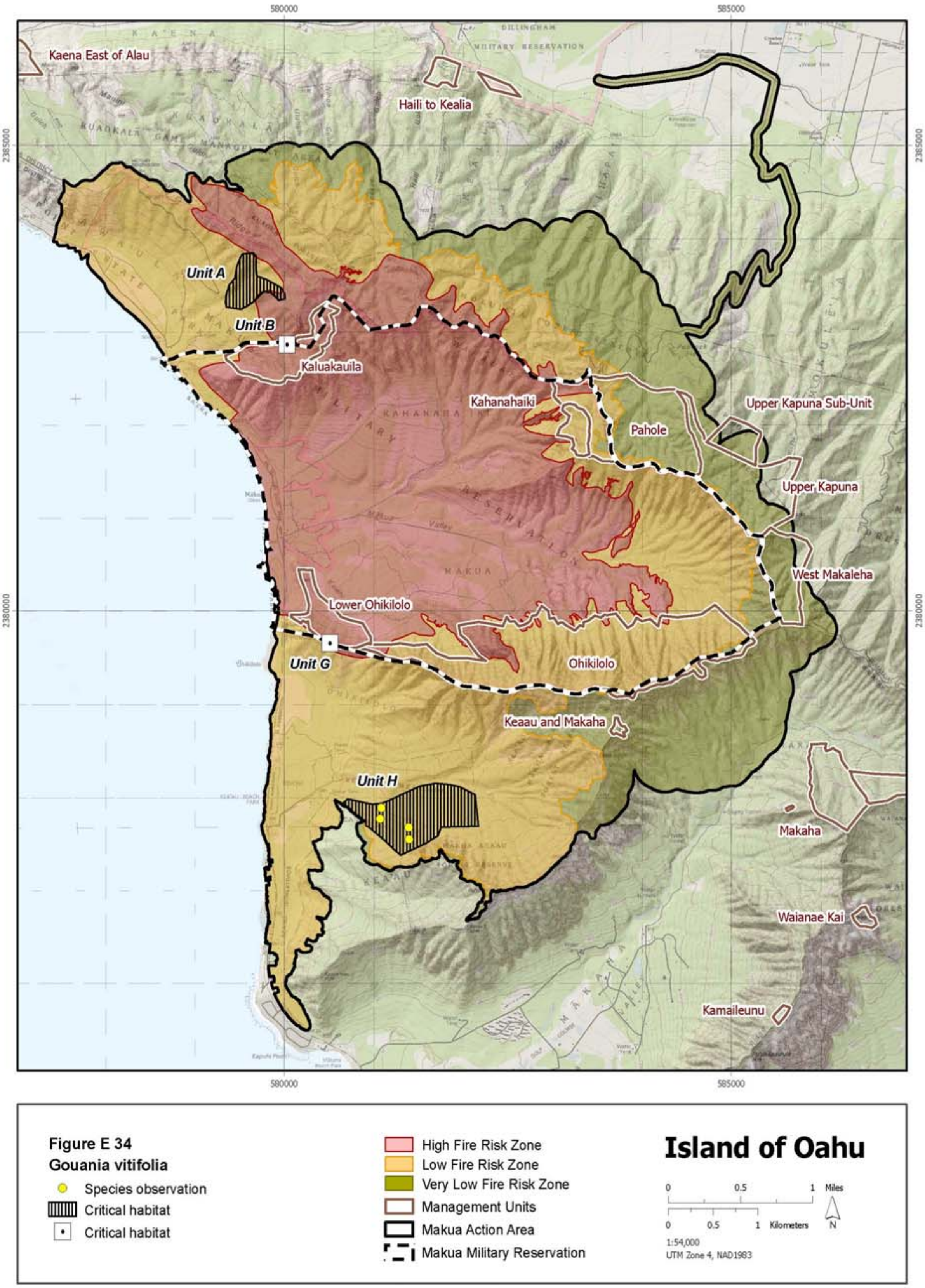


Figure E 34
Gouania vitifolia

EFFECTS OF THE ACTION – *Hibiscus brackenridgei* ssp. *mokuleianus* (Mao hau hele)

The range-wide status of *Hibiscus brackenridgei* ssp. *mokuleianus* is now limited to 669 total mature and immature individuals *in situ*. This subspecies is characterized by five *in situ* population units which contain fewer than 20 mature individuals each. Sixteen mature plants (accounting for 33 percent of all *in situ* mature individuals) and four additional immature plants, (accounting for 2 percent of all known *in situ Hibiscus brackenridgei* ssp. *mokuleianus*) grow in the Makua action area (Figure E 35). An experimental outplanting site, containing 35 additional plants, is located in the Kaluakauila Management Unit (U.S. Army Garrison 2006c). Throughout its range, this species grows in dry, low elevation sites, within or adjacent to previously burned areas dominated by invasive exotic grass (Beavers 2007a). Because of its low numbers and high range-wide fire, weed, and ungulate threats, *H. brackenridgei* ssp. *mokuleianus* already is in a phase of quasi-extinction with numbers that have declined to the point where demographic or environmental stochasticity can result in extirpation. We infer from these circumstances, conservation biology principles, and examples from other species that *H. brackenridgei* ssp. *mokuleianus* has a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire could eliminate expectation of its long-term persistence. Because of its limited population status, restricted distribution, high percentage of individuals in the action area, and risk of training-related wildland fire, this species has been identified as an at risk species. *Hibiscus brackenridgei* ssp. *mokuleianus* was identified as an expedited stabilization species as a conservation measure to protect this taxon from extinction while full stabilization measures are being implemented.

Species Response to the Proposed Action

The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Hibiscus brackenridgei* ssp. *mokuleianus* individuals in the Makua (*in situ*) and Kaluakauila (reintroduced experimental) population units. *Hibiscus brackenridgei* ssp. *mokuleianus* in the action area also will be exposed to the direct and indirect impacts of non-native plants, particularly alien grass which spreads as a result of wildland fires (see General Effects). Twenty plants in the Makua population unit, located in the Lower Ohikilolo Management Unit and the 35 experimental plants growing in the Kaluakauila Management Unit occur in the high fire risk zone in the action area without the fire risk minimization measures proposed by the Army. These plants could to be burned by fires resulting from live-fire training and by fires started by the public outside the installation.

Army Natural Resources Staff keep all grass cleared from within 2 m (7 ft) of the 20 *Hibiscus brackenridgei* ssp. *mokuleianus* plants in Lower Ohikilolo Management Unit. No live-fire or blank-fire training will take place at Makua when grass cover in the Ohikilolo Management Unit weed control areas is greater than 20 percent (see Figure PD 6). New weapons restrictions, improved grass mowing around the interior of the south lobe of the firebreak road, and improved fire suppression staffing requirements minimize the risk that fires will escape containment by initial attack fire suppression resources, particularly prior to implementation of Column C weapons restrictions (see Table PD 2). Prior to implementation of Column C weapons restrictions, which permit the use of weapons that are more likely to ignite fires outside the firebreak road, a fuelbreak and firebreak will be established to minimize fire risk to the 35 experimental *H. brackenridgei* ssp. *mokuleianus* plants in the Kaluakauila Management Unit (see Project Description Section 3.1.4.2). In the event that a fire threatens this site, the fuel treatments installed along the edge of the forested areas of the Kaluakauila Management Unit will provide firefighters, including red-carded Army Natural Resources Staff and fire suppression helicopters, a high likelihood of successfully preventing fire from burning additional forest in this area. No 2.75-caliber rockets, or Javelin or TOW missiles will be used until expedited stabilization thresholds are achieved for all four stabilization population units of this species.

The potential damage to or loss of *Hibiscus brackenridgei* ssp. *mokuleianus* individuals due to wildland fires associated with live-fire training will be offset by ongoing efforts by the Army to complete stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Stabilization actions including outplanting, ungulate control, off-site Army fire suppression assistance, and genetic storage are likely to result in increased probability that this species will persist. Four population units will be managed for stability because of the extreme fire threat to this taxon, and because a large part of the stabilization relies on reintroductions of these species into unoccupied areas. The fourth population unit will be reintroduced in the Keaau portion of the action area. In addition, a replacement population unit may be identified for the Kaimuhole and Palikea Gulch site, which is on private land that is not currently accessible for large scale conservation actions (U.S. Army Garrison 2006c). *Hibiscus brackenridgei* ssp. *mokuleianus* is successfully propagated from cuttings and many plants can be quickly propagated. The high risk of fire to the Haili to Kawaiu, Kaimuhole and Palikea Gulch, and Keaau population units will be minimized by proposed Army wildland fire suppression assistance to the City and County Fire Department, until these populations can be protected with permanent fuels treatments or until the phenotypes are fully represented in replacement sites (Beavers 2007a).

<u>Conclusion</u>

Despite the ongoing exposure of *Hibiscus brackenridgei* ssp. *mokuleianus* to the project's potential wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will increase baseline numbers of *H. brackenridgei* ssp. *mokuleianus* to expedited stabilization thresholds in four population units, including two outside the action area that will not be vulnerable to training-related wildland fire. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *H. brackenridgei* ssp. *mokuleianus* in the action area and range-wide. Reaching expedited stabilization will improve the likelihood that *H. brackenridgei* ssp. *mokuleianus* will attain full stabilization and enhance its probability of persistence over the long term. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Hibiscus brackenridgei* var. *mokuleianus* Critical Habitat

Less than one percent (0 ha; 0.1 ac) of the total critical habitat for *Hibiscus brackenridgei* var. *mokuleianus* is found in one unit within the Makua action area (see Figure E 35). The critical habitat is located entirely within the high fire risk area. The critical habitat unit provides the primary constituent elements that are essential for the conservation of a portion of one population of at least 300 mature, reproducing individuals in order to meet the recovery goals for *H. brackenridgei* var. *mokuleianus*. The primary constituent elements essential for this species include, but are not limited to, dry shrublands (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a dry shrubland community. It is estimated that all of the critical habitat is located in an area with less than 25 percent native plant cover, indicating that this unit is predominantly characterized by non-native vegetation (K. Kawelo, pers. comm. 2004; 68 FR 35950). Currently unoccupied, this critical habitat unit provides a portion of the habitat necessary for the conservation of one population of *H. brackenridgei*. Portions of this critical habitat may have been impacted by past fire events, which diminishes the conservation value of the habitat by removing the vegetative primary constituent elements. Non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

The critical habitat unit is approximately 0.4 km (0.2 mi) from the fire source, and there is a high risk that a fire started in the impact area could move south and impact this unit. The loss of vegetative primary constituent elements within this unit would remove its ability to provide for the conservation of a portion of one population of *Hibiscus brackenridgei* var. *mokuleianus*. Currently, the Army conducts fuel modification in the immediate habitat area of the *H. brackenridgei* var. *mokuleianus* plants, which will enhance the conservation value of the critical habitat and reduce the risk of fire in this critical habitat unit. In addition, the Army is preparing a wildland fire management plan for the Lower Ohikilolo Management Unit. Implementation of this plan may reduce the risk of fire to *H. brackenridgei* var. *mokuleianus* critical habitat due to construction of a fuel modification zone between the impact area and the adjacent Lower Ohikilolo Management Unit.

To reduce the negative impacts to this critical habitat unit from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of the critical habitat unit during the revegetation process, the ability of this unit to provide a portion of the habitat essential for the conservation of one population of *Hibiscus brackenridgei* var. *mokuleianus* will be retained in the long term.

<u>Conclusion</u>

Less than one percent of the total State-wide critical habitat for *Hibiscus brackenridgei* var. *mokuleianus* is located within the Makua action area and is entirely within the high fire risk area.

Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to fuel modification currently being implemented in the immediate habitat area of the *H. brackenridgei* plants themselves. Fuel modification will enhance the conservation value of the critical habitat and reduce the risk of fire in this critical habitat unit. In addition, the Army is preparing a wildland fire management plan for the Lower Ohikilolo Management Unit. Implementation of this plan may reduce the risk of fire to *H. brackenridgei* var. *mokuleianus* critical habitat due to construction of a fuel modification zone between the impact area and the adjacent Lower Ohikilolo Management Unit. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *H. brackenridgei* var. *mokuleianus* critical habitat in the evaluation of the affect of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of this area by the Army will provide habitat essential for the conservation of *H. brackenridgei* var. *mokuleianus* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *H. brackenridgei* var. *mokuleianus*.

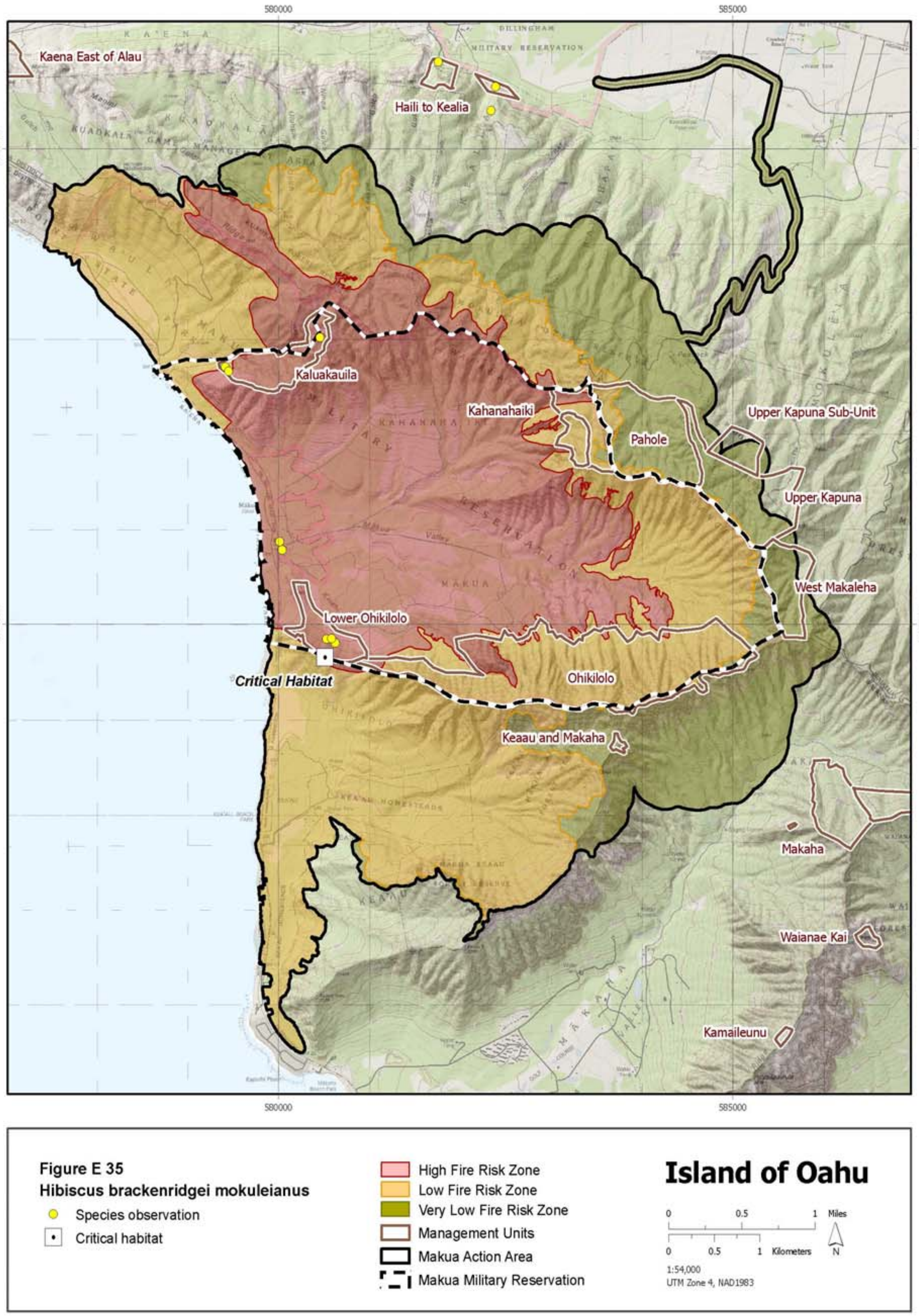


Figure E 35
Hibiscus brackenridgei mokuleianus

EFFECTS OF THE ACTION – *Neraudia angulata* (No Common Name)

There are approximately 130 individuals of *Neraudia angulata* (Waianae endemic) located in the Makua action area. All individuals area located in the Kaluakauila and Ohikilolo management units in the high fire risk zone (30 individuals), and in the low fire risk zone (100 individuals) (Figure E 36). Stabilization goals established for this species include four populations of 100 mature, reproducing individuals, with all threats abated.

The action area contains about 30 percent of all remaining *Neraudia angulata* individuals and about 33 percent of all mature individuals, which is more than the total number of individuals required to meet the criteria for classification as an at-risk taxa. However, the Army agreed to include this species in its expedited stabilization efforts due to the vulnerability of Kaluakauila to training-related fires. The Army Natural Resources Staff have used this management unit as an augmentation site for this species. *Neraudia angulata* may be in a phase of quasi-extinction because numbers have declined to the point where demographic or environmental stochasticity alone can result in extirpation (see General Effects – Small Population Size). We infer from these circumstances, conservation biology principles, and examples from other species that *N. angulata* has a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence. Additionally, the apparent increase in abundance of *N. angulata* is due primarily to discovery of new individuals and augmentation (see Status and Baseline).

<u>Species Response to the Proposed Action</u>

Over the next 30 years, *Neraudia angulata* individuals in the Kaluakauila, Makua, and Punapohaku population units may be exposed to the direct and indirect effects of training-related wildland fire in the high and low fire risk zones. As a shrub of forest and open settings, all individuals and life stages are vulnerable to the risk of high and low severity wildland fires. The 30 *N. angulata* plants in the high fire risk zone are very susceptible to training-related wildland fires. The Kaluakauila Management Unit is located in a xeric area surrounded by flammable grasses and shrubs established from historic fires, and therefore, *N. angulata* individuals are at high risk of burning in future training-related wildland fires. The majority of these plants reside is a small 24.3 ha (60 ac) remnant forest that has protected them to date. However, as fires sweep through the area the forest edge is continually impacted and edge habitat is lost as described in the General Effects – Fire Suppression. To minimize the fire risk to this species and the Kaluakauila Management Unit, a 20-m wide (66-ft wide) fuelbreak, with its imbedded firebreak, adjacent to the forested areas will provide firefighters, including red-carded Army Natural Resources Staff and fire suppression helicopters, a high likelihood of successfully preventing fire from burning additional forest in this area.

The 100 or so *Neraudia angulata* located on Ohikilolo Ridge (see Figure E 36) are also at risk from fire spread into Ohikilolo Ridge from the valley floor, or ignition on the ridge from a misfired long-range, live-fire weapon such as the TOW, or from a spot fire resulting from an intense grass fire and high winds in the valley. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Since the vegetation is on the cliff face of Ohikilolo is sparse the risk of a large fire is low if fire suppression is quickly deployed (see General Effects - Fire Suppression).

To further reduce the risk to all *Neraudia angulata* individuals, certain weapons systems and munitions will be restricted until fire protection fuelbreaks are in place and expedited stabilization thresholds are achieved. No long-range weaponry will be used until expedited stabilization goals are met for all stabilization population units. In the action area, expedited stabilization actions will involve continued augmentation of *N. angulata* in the Makua population unit and reintroduction in the Kaluakauila population unit. Outside the action area, the Manuwai and Waianae Kai Mauka population units will be protected by future fence exclosures. Four population units will be managed as stabilization population units in order to represent the full, genetic, geographical and morphological complement of this species.

Neraudia angulata in the action area also will be exposed to the direct and indirect impacts of non-native ungulates and weeds. The direct and indirect effects of non-native weeds and invertebrates will reduce the vigor, reproduction, recruitment, and survival of individual plants. The Makua and Kaluakauila population units are being managed as stabilization populations within the action area and are located within the fenced Ohikilolo and Kaluakauila management units, respectively, and are partially controlled for weeds.

Conclusion

Despite the ongoing exposure of *Neraudia angulata* to project wildland fire impacts, Army conservation and stewardship programs will increase the baseline number of individuals. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will increase the numbers of *N. angulata* to meet the targets established for expedited stabilization. These goals include two population units outside the action area not vulnerable to training-related wildland fire. Reaching expedited stabilization goals will improve the likelihood that *N. angulata* will meet the criteria of full stabilization and enhance its probability of persistence over the long term. Therefore, based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Neraudia angulata* Critical Habitat

There are two critical habitat units within the Makua action area, comprising one percent, 6 ha (15 ac), of the total State-wide critical habitat for *Neraudia angulata* (see Figure E 36). All units are located within the high fire risk area. Critical habitat unit A, currently unoccupied, was designated to provide a portion of the habitat necessary for the conservation of one population of *N. angulata* in order to meet recovery goals for this species. Although degraded, unit B still supports individuals of *N. angulata* and provides habitat that is necessary for the expansion of this population. Each population will be comprised of at least 300 mature, reproducing individuals of *N. angulata* (68 FR 35950). The primary constituent elements that are essential for this species include, but are not limited to, slopes, ledges, or gulches in lowland mesic or dry forest. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within lowland dry or mesic forest. It is estimated that more than one-half of the critical habitat in the action area is predominantly non-native vegetation (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that these critical habitat units are currently degraded due to non-native plant encroachment.

Portions of critical habitat unit A have been impacted by past fire events that diminish the conservation value of this habitat. The loss of the vegetative primary constituent elements from fire and the subsequent invasion by non-native plant species precludes natural recruitment. In the absence of habitat management, fires resulting from future training actions could contribute to the degradation of these critical habitat units.

Critical habitat unit A is 2 hectares (5 ac) and is entirely within the Kaluakauila Management Unit within the high fire risk area (see Figure E 36). Due to the close proximity of this unit to the fire source, there is a risk that if a fire started in the impact area, it could move north and impact this unit. The risk is increased due to the surrounding vegetation that is dominated by *Panicum maximum* (see Figure PD 2), which is highly flammable and can increase the frequency and size of wildland fires (Beavers et al 1999). The prescribed burn in 2003 encroached into the edge of unit A (G. Enriques, pers. comm. 2003). The consequence of this fire event is the subsequent encroachment of non-native grassland that provides more flammable fuel and increases the potential for fires in the future. The loss of vegetative primary constituent elements of this critical habitat unit would remove its ability to provide a portion of the habitat necessary for the conservation of one population of *Neraudia angulata*. To reduce the fire risk, the Army is preparing a fire management plan for the Kaluakauila Management Unit. Implementation of this plan will reduce the risk of fire due to the construction of a fuel modification zone between the impact area and the management unit. Fuel modification will buffer the Kaluakauila Management Unit from fires that spread outside the impact area and in turn help reduce the probability that critical habitat unit A will burn. In addition, this management unit is currently fenced and the Army is working to reduce non-native plants within the exclosure. The removal of ungulates and non-native invasive plant species within this management unit enhances the conservation value of the critical habitat unit A.

Critical habitat unit B is 90 ha (222 ac) and entirely within a low and very low fire risk area. A small portion of this critical habitat unit extends into the Makua action area. Forty percent, or 36 ha (89 ac), of this unit is located within two management units. Thirty ha (73 ac) are in the Upper Kapuna Sub-unit Management Unit and 6 ha (16 ac) are in the Upper Kapuna Management Unit. The remaining 54 ha (133 ac) of this critical habitat unit is found outside of any management unit. Unit B is approximately 1.3 km (0.8 mi) from the impact area on its eastern end, and there is a risk that a fire started in the impact area could move east and impact this unit. The loss of vegetative primary constituent elements of this unit would remove its ability to provide habitat necessary for the conservation of one population of *Neraudia angulata*. However, the fire risk is decreased due to the surrounding mesic forest vegetation, which is of low flammability and the buffer of surrounding management units, also of low flammability and managed to reduce alien plant species, and, therefore, fuel load (Beavers et al 1999). Pursuant to the Makua Implementation Plan, fuel modification will occur within these management units through the control of alien plant species, some of which are highly flammable. In addition, these management units will be fenced and the Army will work to reduce non-native plant species within the fenced area. The removal of ungulates and non-native invasive plant species within these management units enhances the conservation value of critical habitat unit B. The remaining critical habitat outside of the management unit is separated from the impact area by the Pahole and the Upper Kapuna, Upper Kapuna Sub-Unit management units. The fuel modification activities, plus other conservation measures implemented by the Army for species stabilization, will further reduce the risk of fire to the portion of the critical habitat outside of the management unit.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and the control of non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the revegetation process, their ability to provide habitat essential for the conservation of *Neraudia angulata* will be retained in the long-term.

Conclusion

One hundred percent of the critical habitat units for *Neraudia angulata* in the Makua action area is located in the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced for critical habitat unit A due to the construction of a fuel modification zone between the impact area and Kaluakauila Management Unit. In addition, fuel reduction within the management unit will further buffer critical habitat unit A from fire. Fuel reduction within the Upper Kapuna, Upper Kapuna Sub-Unit management units will buffer critical habitat unit B from fire. The critical habitat unit within Kaluakauila Management Unit and the portion of critical habitat unit B that is within Upper Kapuna, Upper Kapuna Sub-Unit management units will be managed to improve their baseline quality, pursuant to the Makua Implementation Plan. Without this management, these critical habitat units would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *N. angulata* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *N. angulata* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat.

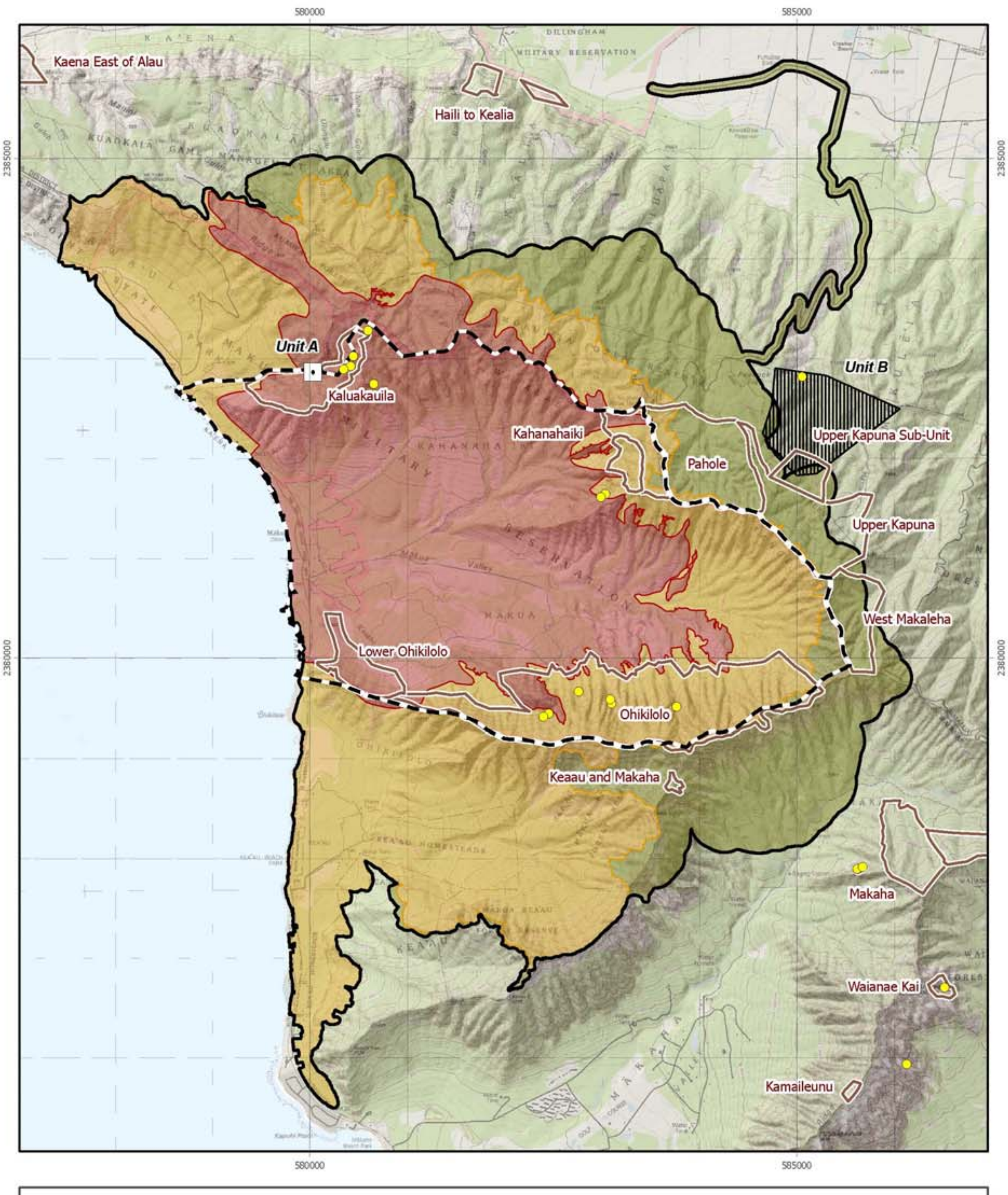


Figure E 36
Neraudia angulata

Species observation
Critical habitat
Critical habitat

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Phyllostegia kaalaensis* (No Common Name)

Phyllostegia kaalaensis is a short-lived perennial herbaceous plant with no known naturally occurring individuals in existence today. There are only two, reintroduced immature plants, located in the Upper Kapuna Management Unit. The Army Natural Resources Staff reintroduced *P. kaalaensis* at two sites in the Keawapilau to Pahole Population Unit (Figure E 37); however, 45 of the original 47 outplanted individuals perished for unknown reasons. The Army Natural Resources Staff are looking into possible microsite differences and age of greenhouse stock to determine if these factors explain the low success rate for this species (U.S. Army Garrison, 2006c). Eventually there will be four population units for this species defined as 50 mature, reproducing individuals.

Phyllostegia kaalaensis is an expedited stabilization species due to the low numbers and extreme risk of extinction; *P. kaalaensis* already is in a phase of quasi-extinction with numbers that have declined to the point where demographic or environmental stochasticity alone can result in extirpation (see General Effects – Small Population Size). We infer from these circumstances, conservation biology principles, and examples from other species that *P. kaalaensis* has a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence.

<u>Species Response to the Proposed Action</u>

Over the next 30 years, *Phyllostegia kaalaensis* individuals in the Keawapilau to Pahole Population Unit will be exposed to the direct and indirect effects of training-related wildland fire in the very low fire risk zone. However, the risk of extirpation *P. kaalaensis* from a training-related fire is very low due to its location in the mesic forests of Kapuna and distance (2.9 km; 1.8 mi) from the training impact area. We estimate that a misfired weapon landing in forest and shrub areas will burn approximately 0.1 ha (0.3 ac) of forest prior to fire suppression measures extinguishing the fire. Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period. However, to avoid the risk of an undetected fire, the Army will conduct an aerial survey in a helicopter for 1-hour post-training to check for smoke from a misfired round (see General Effects - Fire Suppression).

No long-range weaponry will be used until expedited stabilization thresholds are achieved for all stabilization population units for *Phyllostegia kaalaensis*. Expedited stabilization will involve continued reintroduction and augmentation of all *P. kaalaensis* population units inside and outside of the action area. *Phyllostegia kaalaensis* can be propagated from cuttings, but outplantings have very low survival. Stabilization will depend on developing outplanting techniques and identifying optimum planting site characteristics for this species. The Army will identify a fourth stabilization population unit when successful outplanting techniques have been developed.

Other Risk Reduction Factors

Phyllostegia kaalaensis in the action area also will be exposed to the direct and indirect impacts of non-native weeds and pigs. The cause of the extirpation of all naturally occurring individuals of this species is currently unknown; however, the Army Natural Resources Staff are working with the Makua Implementation Team in an attempt to address the problem. Only the Pahole portion of the Keawapilau to Pahole Population Unit is within the fenced Pahole Management Unit; all reintroduction sites are controlled for weeds. Outside the action area, the Makaha and Manuwai population units will be reintroduced in the future after fencing is in place.

Conclusion

Despite the ongoing exposure of *Phyllostegia kaalaensis* to project wildland fire impacts, fire risk to this species is very low, and Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. In this case, *P. kaalaensis* would be extinct in the wild without all of the stabilization efforts conducted by the Army's Natural Resources Staff. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will increase the number of *P. kaalaensis* in the wild and, therefore, the minimal risk of this species being impacted by a wildland fire is far outweighed by the benefit of its stabilization. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *P. kaalaensis* in and adjacent to the action area. We further believe that this species is unlikely to survive without the Army's expedited and full stabilization efforts.

Effects of Action on *Phyllostegia kaalaensis* Critical Habitat

There are two critical habitat units within the Makua action area, representing 13 percent (107 ha; 263 ac) of the total critical habitat for *Phyllostegia kaalaensis*. Critical habitat units A and B are located in the northeastern portion of the action area within the two low fire risk zones with 8.1 ha (20 ac) in the low fire risk area and 98.4 hectares (243 ac) in the very low fire risk area. Critical habitat unit A was designated to provide habitat for the conservation of one population of *P. kaalaensis* (see Figure E 37). The portion of critical habitat unit B inside the action area, together with 348 ha (860 ac) outside the action area, was designated to provide habitat for the conservation of six populations of *P. kaalaensis.* To meet recovery goals, each population should be comprised of at least 300 mature, reproducing individuals for this species (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, gulch slopes, bottoms, or almost vertical rock faces in mesic forest or *Sapindus oahuensis* forest. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found in mesic forest or *S. oahuensis* forest. It is estimated that almost one-half of the critical habitat is located in areas with predominately non-native vegetation (U.S. Army Garrison 2003b; K. Kawelo, pers. comm. 2004; 68 FR 35950; 68 FR 35950). This indicates that the critical habitat is somewhat degraded due to non-native plant encroachment. In the absence of habitat management, fires from future training actions could add to the degradation of these critical habitat units by removing the remaining vegetative primary constituent elements.

There is a risk that a fire started in the impact area could move east and impact critical habitat units A and B, or that a misfired round could ignite outside of the firebreak road and burn into these units. The loss of vegetative primary constituent elements within these two critical habitat units, together with the 348 ha (860 ac) outside the action area, would remove their ability to provide for the conservation of a total of seven populations of *Phyllostegia kaalaensis*. A prescribed burn in 2003 encroached within 0.3 km (0.2 mi) of critical habitat unit A (G. Enriques, pers. comm. 2003). The consequences of this and other fire events is the subsequent encroachment of non-native vegetation that provides more flammable fuel in nearby areas and increases the potential for future fires. However, the risk of fire is reduced due to the low flammability of the surrounding vegetation (mesic forest), spatial separation from the impact area, and the beneficial resource management actions conducted by the Army in the management units, pursuant to the Makua Implementation Plan. Critical habitat unit A (57 ha; 140 ac) is within the Pahole Management Unit. This management unit is fenced, and the Army is removing non-native plants and ungulates from the fenced areas. The western boundary of critical habitat unit A borders the Kahanahaiki Management Unit. The Army will develop and implement a wildland fire management plan for the Kahanahaiki Management Unit. Implementation of this plan will reduce the risk of fire to *P. kaalaensis* critical habitat due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit. Fuel modification will buffer the Kahanahaiki Management Unit from fires that spread outside the impact area and therefore buffer the critical habitat.

Thirty-nine percent of critical habitat unit B is located in several management units to include Lower and Upper Kapuna, West Makaleha, Central and East Makaleha management units. The Army has fenced portions of the West Makaleha Management Unit and plans to fence the remainder of this unit, as well as the Upper Kapuna, and Central and East Makaleha management units, pursuant to the Makua Implementation Plan. Ungulates will be removed from all fenced areas. The Army is working to reduce non-native plants in all of these management units. The Army is also conducting rat control in the West Makaleha Management Unit to reduce their impacts on listed and associated native plants. All of these resource management actions in the management units enhance the conservation value of critical habitat. The remaining critical habitat outside of unit B (approximately 50 ha; 133 ac) is buffered from the impact area by the management units themselves. The fuel modification activities and the other threat reduction measures implemented by the Army for species stabilization will further reduce the risk of fire to the critical habitat outside of the management units.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and the control of non-native, competitive plant species. While there may be a temporal loss of the conservation value of the critical habitat units during the revegetation process, the ability of critical habitat units A and B to provide habitat essential for the conservation of *Phyllostegia kaalaensis* will be retained in the long-term.

Conclusion

The two critical habitat units for *Phyllostegia kaalaensis* in the Makua action area are located in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire to the critical habitat will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit that is adjacent to critical habitat in the Pahole Management Unit. Fuel reduction within the management units will buffer critical habitat units A and B from fire. The critical habitat that is within Central and East Makaleha, Kahanahaiki, Upper Kapuna Sub-unit, Pahole, Upper Kapuna, and the West Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, these two critical habitat units could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *P. kaalaensis* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *P. kaalaensis* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *P. kaalaensis*.

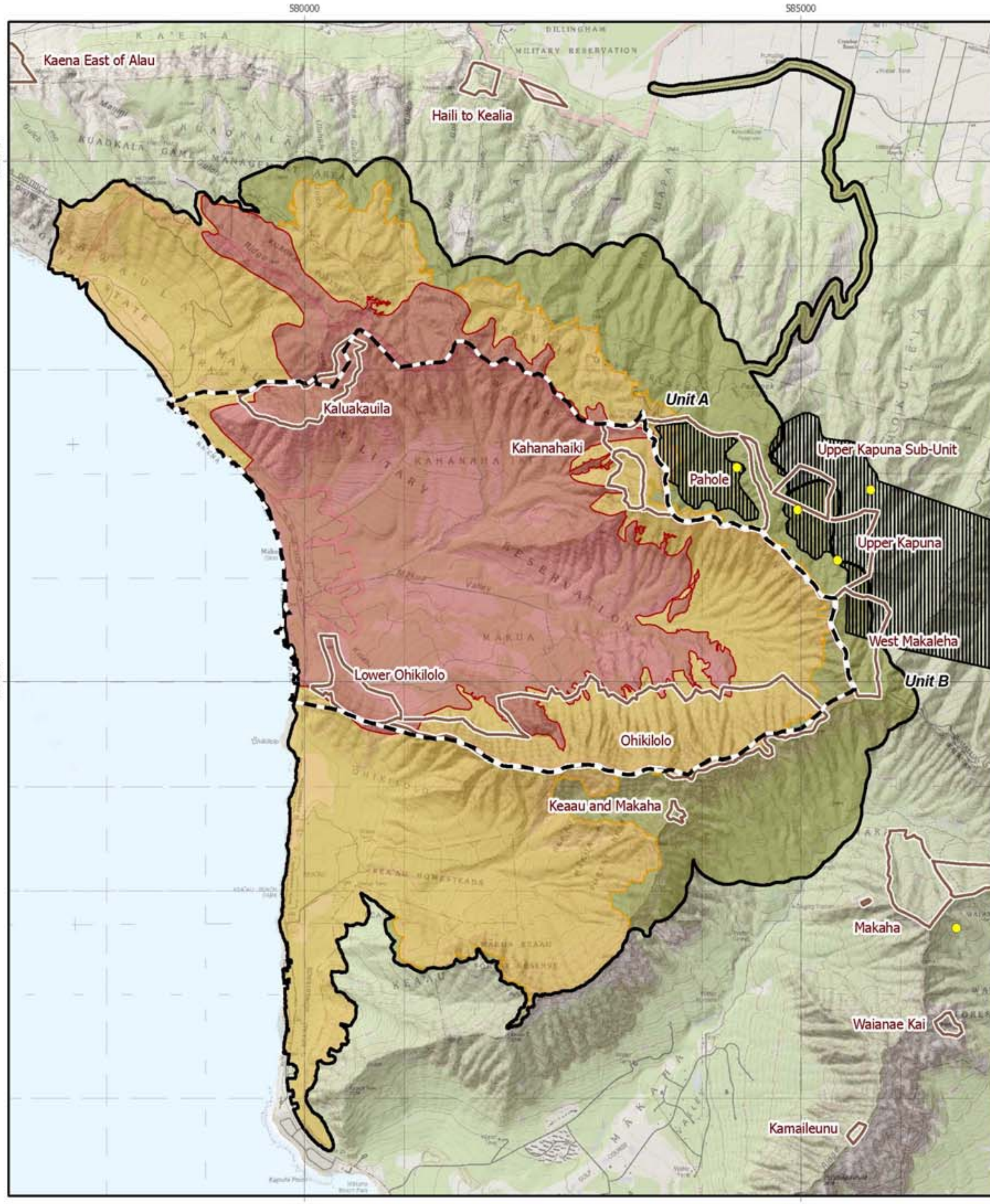


Figure E 37
Phyllostegia kaalaensis

- Species observation
- Critical habitat

- High Fire Risk Zone
- Low Fire Risk Zone
- Very Low Fire Risk Zone
- Management Units
- Makua Action Area
- Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Sanicula mariversa* (No Common Name)

Sanicula mariversa is a perennial herbaceous plant with a range-wide status of only 225 individuals. Approximately 80 percent of all remaining *S. mariversa* individuals are found in the action area in the Ohikilolo and Keaau population units. About 52 individuals occur in the low fire risk and 128 in the very low fire risk zone (Figure E 38). *Sanicula mariversa* has been identified as a at risk species based on the limited population status, restricted distribution, high percentage of individuals in the action area, and risk of training-related wildland fire. Therefore, *S. mariversa* was identified as an expedited stabilization species as a conservation measure to protect this taxon from extirpation while full stabilization measures are being implemented. It is likely *S. mariversa* is already is in a phase of quasi-extinction with numbers that have declined to the point where demographic or environmental stochasticity alone can result in extirpation (see General Effects – Small Population Size). We infer from these circumstances, conservation biology principles, and examples from other species that *S. mariversa* has a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence.

<u>Analysis for Effects of the Proposed Action</u>

Over the next 30 years, the proposed action could result in injury and death of *Sanicula mariversa* individuals as a result of training-related wildland fire. Fifty-two individuals of *S. mariversa* are located on the upper ridgeline of the Ohikilolo Management Unit (see Figure E 38). A training-related wildland fire could spread into Ohikilolo Ridge from the valley floor, or start on the ridge from a misfired long-range, live-fire weapon such as the TOW, or ignite from a spot fire during high winds. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). The risk of a fire spreading from the valley floor (impact area) up the ridge is very low due to sparse vegetation on the cliff face of Ohikilolo Ridge and the fire suppression measures that will be enacted that will impede fire spread prior to impacting the top of Ohikilolo ridgeline (see General Effects - Fire Suppression). Even if the fire did reach the top of the ridgeline the risk of burning all *S. mariversa* plants in one fire is very low due to their distribution.

Approximately 128 *Sanicula mariversa* are located in the very low fire risk zone near the Keaau and Makaha Management Unit. These plants beyond the Ohikilolo Ridge are unlikely to be burned as a result of training-related fires due to their distance (1.6 km; 1 m) from the impact area in conjunction with fire suppression response. At 14 mature individuals, the Keaau population unit in the action area is far from stable (defined as 100 mature, reproducing individuals), and the Ohikilolo population unit contains no mature individuals.

Sanicula mariversa is also exposed to the suite of threats as described and analyzed in the General Effects. The direct and indirect effects of non-native grasses, goats, and erosion will reduce the vigor, reproduction, recruitment, and survival of individual plants. The overall response of *S. mariversa* to project impacts will be a measurable reduction in baseline numbers, distribution, and reproduction within the action area population units.

In the action area, the Ohikilolo population unit is fenced and controlled for weeds; the Keaau population unit, located within a State Game Management Area, is not fenced nor weeded. No long-range weaponry will be used until expedited stabilization thresholds are achieved for all stabilization population units. Expedited stabilization will involve continued habitat management for *Sanicula mariversa* within the two action area population units, and in the Kamaileunu population unit outside the action area. Propagation and outplanting techniques have not yet been identified; the dormancy cycle of this species may preclude feasible propagation and reintroduction. Stabilization will require monitoring and study of population demographics over several years to determine dormancy effects on survival, reproduction, and recruitment.

<u>Conclusion</u>

Despite the ongoing exposure of *Sanicula mariversa* to training-related wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions will increase baseline numbers of *S. mariversa* to stability thresholds in three population units. However, the risk of training-related wildland fire to individuals within the action area is low to very low and one of the action area population units is located in manageable habitat where ungulate and weed threats can be controlled. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *S. mariversa* in and adjacent to the action area over the next 30 years. Reaching expedited stabilization will improve the likelihood that *S. mariversa* will attain full stabilization and enhance its probability of persistence over the long term. Overall, the minimal risk of impact from training-related actions and the beneficial resource management activities to be conducted at Makua outweigh the Army training-related risks to this species.

Effects of the Action on *Sanicula mariversa* Critical Habitat

There are two critical habitat units within the Makua action area, comprising approximately 11 percent (10 ha; 25 ac) of the total critical habitat for *Sanicula mariversa*. Critical habitat units A and D, located in the south-central portion of the action area, are entirely within the low fire risk zones, with 0.33 ha (0.82 ac) in the low fire risk area and 6.57 ha (16.23 ac) in the very low fire risk area (see Figure E 38). The two units, combined, provide habitat for the conservation of one population of at least 300 mature, reproducing individuals of *S. mariversa* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, dry, well-drained slopes or rock faces in mesic shrublands or open grassy area. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within mesic shrublands or open grassy areas. It is estimated that slightly more than one-half of the critical habitat within the action area is found in an area with less than 50 percent native plant cover (K. Kawelo, pers. comm. 2004; 68 FR 35950). This indicates that these critical habitat units are currently degraded due to non-native plant encroachment. Portions of these units may have been impacted by past fire events, which further diminishes the conservation value of this habitat. Fire removes the vegetative primary constituent elements, and non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of these critical habitat units by removing the remaining vegetative primary constituent elements.

Critical habitat unit A is approximately 10 ha (25 ac) on Ohikilolo Ridge. Approximately one hectare (2 ac) of this critical habitat unit is located in the Ohikilolo Management Unit, straddling the low and high fire risk boundary. The remaining 9 ha (23 ac) of critical habitat are outside of the management unit and in the low and very low fire risk areas. The loss of vegetative primary constituent elements of this unit would remove its ability to provide habitat for the conservation for a portion of one population of *Sanicula mariversa*. See *Dubautia herbstobatae* for a discussion of the effects of fire and management.

Critical habitat unit D is 3 ha (7 ac). Almost 2 ha (4.5 ac) or approximately 18 percent of the critical habitat is in the Keau and Makaha Management Unit. A small portion (0.6 ha; 1.5 ac), or 34 percent, of the critical habitat in the management unit is within the high fire risk area. The remainder of the critical habitat in the management unit is in the low and very low fire risk areas. The remaining 8 ha (19 ac) of critical habitat are outside the management unit and mostly within the low and very low fire risk areas. Critical habitat unit D is approximately 1.6 km (1 mi) from the impact area and the risk of fire in this xeric, lowland grassland habitat is high. The prescribed burn in 2003 encroached within 1 km (0.6 mi) of unit D (see Figure E 38 and Figure E 3) (G. Enriques, pers. comm. 2003). The consequence of this fire is the encroachment of non-native grassland that provides more flammable fuel and increases the potential for fires in the future. The loss of vegetative primary constituent elements of this unit would remove its ability to provide a portion of habitat for the conservation of one population of *Sanicula mariversa*. Presently, fuel modification conducted for critical habitat unit A will also reduce the risk of fire in this area. In the Upper Keaau and Makaleha management units, the Army will fence and remove ungulates and reduce non-native plants, pursuant to the Makua Implementation Plan. In addition, the control of non-native species in the Ohikilolo Management Unit will provide an additional buffer between the Upper Keaau and Makaleha management units and the impact area. These actions will decrease the risk of fire within the management units by reducing the fuel load in the area.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the revegetation process, their ability to provide habitat essential for the conservation of two populations of *Sanicula mariversa* will be retained in the long-term.

Conclusion

One hundred percent of the critical habitat unit for *Sanicula mariversa* in the Makua action area is located outside of the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of fuel modification zones between the impact area and their respective management units. In addition, fuel reduction within the Makaleha and Upper Keaau management units will further buffer critical habitat units A and B from fire. The portion of critical habitat in unit A that is within the Ohikilolo Management Unit and the portion within the Upper Keaau and Makaleha management units will be managed to improve their baseline quality pursuant to the Makua Implementation Plan. Without this management, these critical habitat units would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *S. mariversa* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *S. mariversa* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *S. mariversa.*

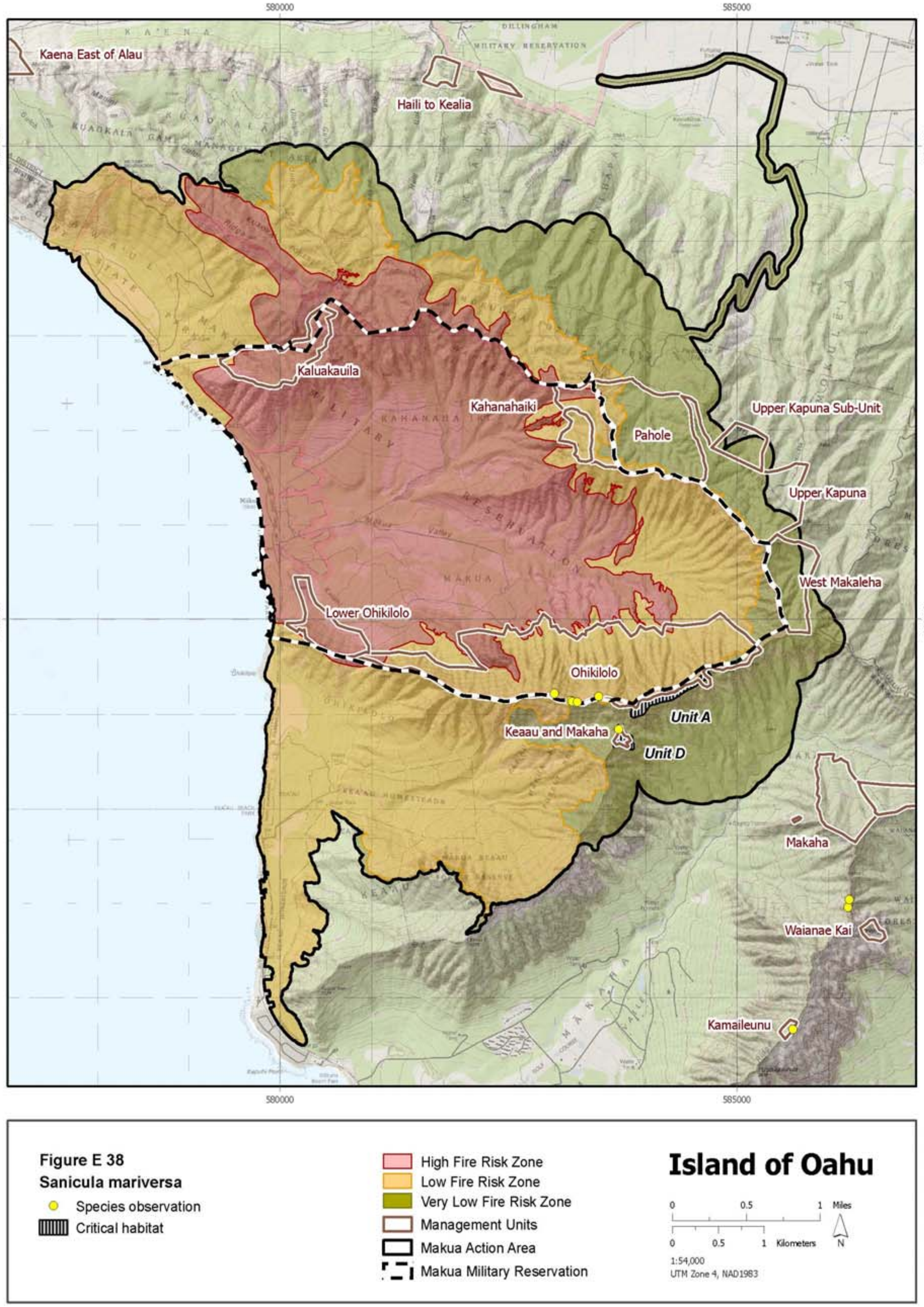


Figure E 38
Sanicula mariversa

EFFECTS OF THE ACTION – *Schiedea nuttallii* (No Common Name)

The range-wide status of the subshrub *Schiedea nuttallii* is now limited to approximately 100 individuals. With approximately 80 mature individuals, the Kahanahaiki to Pahole population unit is the only stabilization population in the action area with more than 50 mature reproducing individuals, but is not considered fully stabilized because threats are not controlled and numbers are maintained primarily through augmentation (Figure E 39). The Kapuna-Keawapilau Ridge population unit with only three mature individuals is far from reaching the criteria established for stabilization populations. Any loss of action area plants will reduce baseline numbers and available propagule material for augmentation and reintroduction, and prolong the time needed to achieve expedited and full stabilization.

This species is extremely rare with only four extant population site, one consisting of a single plant. Hence, this species is characterized by a precipitous decline in the number of individuals, extremely low genetic variability, and extirpation of the majority of naturally occurring plants. Because of these factors, *Schiedea nuttallii* already is in a phase of quasi-extinction with numbers declined to the point where demographic or environmental stochasticity alone can result in extirpation (see General Effects – Small Population Size). We infer from these circumstances, conservation biology principles, and examples from other species that *S. nuttallii* has a very high background extinction risk, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence. Therefore, *S. nuttallii* has been identified as an at risk species based on its limited population status, restricted distribution, high percentage of individuals in the action area, and risk of training-related wildland fire. *Schiedea nuttallii* was identified as an expedited stabilization species as a conservation measure to protect these taxa from extirpation while full stabilization measures are being implemented.

<u>Species Response to the Proposed Action</u>

Over the next 30 years, *Schiedea nuttallii* individuals in the Kahanahaiki to Pahole and Kapuna-Keawapilau Ridge population units will be exposed to the direct and indirect effects of training-related wildland fire in the low and very low fire risk zones. For this Biological Opinion, we are relying on the Army's most recent status update (U.S. Army Garrison 2006d), which is based on the action area used to develop the Makua Implementation Plan in 2003. This 2003 action area differs from the 2007 action area under consideration for this opinion (see discussion in the Introduction to Status and Environmental Baseline of the Species and Critical Habitat). For *S. nuttallii*, however, we are confident that the Kapuna to Keawapilau Ridge population unit is outside the currently delineated action area (M. Mansker, U.S. Army Garrison, pers. comm. 2006).

As a small, mostly herbaceous understory subshrub, all individuals and life stages are vulnerable to the risk of high and low severity wildland fires. About 90 individuals occur in the low fire risk zone and five in the very low fire risk zone. Lack of alien grass control in the lower Pahole portion of the population unit, however, increases exposure of nearby native and mixed forest areas to long-term fire encroachment. Certain weapons systems and munitions will be restricted until a fire protection system is in place for the Kahanahaiki Management Unit and expedited stabilization thresholds are achieved for at-risk taxa that occur in that management unit. No long-range weaponry will be used until expedited stabilization thresholds are achieved in all stabilization population units. Expedited stabilization will involve continued augmentation of *S. nuttallii* in the Kahanahaiki to Pahole population unit inside the action area. Outside the action area, the Kapuna to Keawapilau Ridge population unit will be augmented and the Makaha population unit will be newly established through reintroduction. Although *S. nuttallii* has been successfully propagated from seed and cuttings, stabilization will depend on developing slug and black twig borer control techniques to increase survival and recruitment. After expedited stabilization is complete and long-range incendiary weapons are used at Makua, we estimate that a misfired live-fire weapon landing in forest and shrub areas will burn approximately 0.1 ha (0.3 ac) prior to fire suppression measures extinguishing the fire. Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period. However, to avoid the risk of an undetected fire, the Army will conduct an aerial survey in a helicopter for one hour post-training to check for smoke from a misfired round (see General Effects - Fire Suppression).

Schiedea nuttallii in the action area also will be exposed to the direct and indirect impacts of non-native species such as molasses grass, slugs, and perhaps black twig borers. Slug and black twig borer damage is particularly threatening to the survival and recovery of this species because no feasible control methods are available for field situations. The direct and indirect effects of non-native weeds and invertebrates will reduce the vigor, reproduction, recruitment, and survival of individual plants. Pursuant to stabilization actions, both portions of the Kahanahaiki to Pahole population unit are fenced to exclude feral ungulates; the Kapuna to Keawapilau Ridge population unit is not fenced. All *S. nuttallii* occurrences except those in the lower Pahole portion of the Kahanahaiki to Pahole population unit are regularly controlled for weeds, and individuals under mesic forest canopy are protected from the spread of fire.

Conclusion

Because the action area contains nearly 100 percent of all of the remaining individuals, the environmental baseline of *Schiedea nuttallii* in the action area is virtually equivalent to the status of the species as a whole. Despite the ongoing exposure of *S. nuttallii* to project wildland fire impacts, Army conservation and stewardship programs will improve its baseline condition in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will increase baseline numbers of *S. nuttallii* to stability thresholds. Stabilization of three population units, including two outside the action area that will not be vulnerable to training-related wildland fire, will further reduce the risk of plant loss to training-related wildland fire. Thus, the overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *S. nuttallii* in and adjacent to the action area over the next 30 years. Reaching expedited stabilization criteria will improve the likelihood that *S. nuttallii* will reach the thresholds outlined for stabilization and enhance its probability of persistence over the long term.

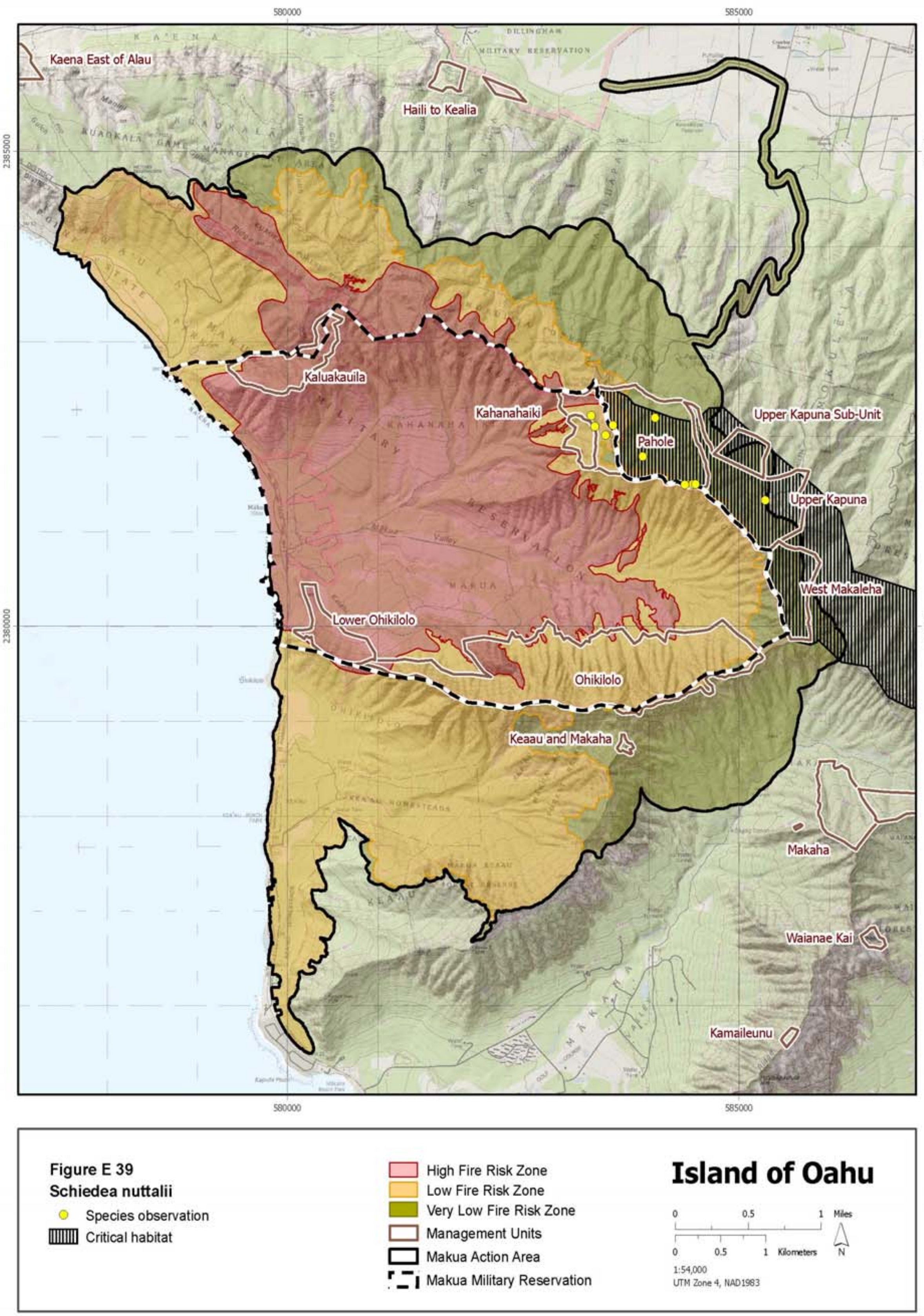
Effects of the Action on *Schiedea nuttallii* Critical Habitat

A total of 200 ha (494 ac), or 16 percent, of the total critical habitat for *Schiedea nuttallii* is located in one unit within the Makua action area. This critical habitat is part of a larger 527 ha (1,304 ac) critical habitat unit that extends outside the Makua action area. Located in the northeastern portion of the action area, almost all critical habitat is in the two low fire risk zones, with 17 ha (42.3 ac) in the low fire risk area and 182 ha (450 ac) in the very low fire risk area (see Figure E 39). The entire critical habitat unit was designated to provide habitat for the conservation of four populations, each of at least 300 mature, reproducing individuals of *S. nuttallii* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, rock walls, forested slopes, or steep walls in *Acacia koa*-*Metrosideros polymorpha* (koa-ohia) lowland mesic forest or ohia-*Dodonaea viscosa* (aalii) forest (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species that are found within koa-ohia lowland mesic forest or ohia-aalii forest on Oahu. It is estimated that nearly one-half of the critical habitat is located in forest habitat comprised of 50 to 75 percent native plant cover, indicating that there is some non-native plant encroachment in this unit (K. Kawelo pers. comm. 2004; 68 FR 35950). Fire diminishes the conservation value of the habitat by removing the vegetative primary constituent elements. Non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires resulting from future training actions could add to the degradation of this critical habitat unit by removing remaining vegetative primary constituent elements.

Approximately 85 percent (170 ha; 421 ac) of the critical habitat for *Schiedea nuttallii* is located within the Pahole, Upper Kapuna and West Makaleha management units (small portion included in East and Central Makaleha Management Unit). Please see *Schiedea obovata* for the effects analysis on the action of training and the proposed activities for the aforementioned management units. The remaining critical habitat outside the management units (30 ha; 72 ac) is separated from the impact area by low and very low fire risk areas and by the above-mentioned management units themselves. Therefore, spatial separation from the impact area, adjacent low and very low fire risk area along the western boundary of the critical habitat unit, fuel modification actions that will be implemented for the Kahanahaiki management unit that is adjacent to the northwestern portion of the critical habitat unit, and the aforementioned activities implemented by the Army for species stabilization in the Pahole, Upper Kapuna, and West Makaleha management units will further reduce the risk of fire to critical habitat inside and outside the management units.

Conclusion

The critical habitat unit for *Schiedea nuttallii* in the Makua action area is almost entirely within the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the adjacent Kahanahaiki Management Unit. In addition, fuel reduction within the management units will further buffer the critical habitat unit from fire. The portion of critical habitat within the Pahole, Upper Kapuna, Upper Kapuna Sub-Unit, and West, Central and East Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *S. nuttallii* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *S. nuttallii* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *S. nuttallii*.


Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
580000
585000
2385000
2380000
Figure E 39
Schiedea nuttalii
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Schiedea obovata* (No Common Name)

The range-wide status of *Schiedea obovata* is now limited to approximately 400 total individuals. About 90 percent of all remaining individuals are located in the action area (Figure E 40). With approximately 100 and 55 mature individuals respectively, the Kahanahaiki to Pahole and the Keawapilau to West Makaleha population units are the only stabilization population in the action area. These units are not considered fully stabilized; threats are not controlled and numbers are maintained primarily through augmentation.

Once found in six sites, this species is now characterized by a decline in the number of individuals and population units, and to date only three populations are known to exist. This species is also characterized by large fluctuations in numbers, limited natural recruitment and low numbers that are increasing only through augmentation and discovery of new individuals. Because of these factors, *Schiedea obovata* already is in a phase of quasi-extinction with numbers declined to the point where demographic or environmental stochasticity alone can result in extirpation (see General Effects – Small Population Size). We infer from these circumstances, conservation biology principles, and examples from other species that *S. obovata* has a very high background extinction risk in the action area and range-wide, and any additional threats associated with training-related wildland fire are likely to eliminate expectation of its long-term persistence. Therefore, *S. obovata* has been identified as an at risk species based on its limited population status, restricted distribution, high percentage of individuals in the action area, and risk of training-related wildland fire. *Schiedea obovata* was identified as an expedited stabilization species as a conservation measure to protect these taxa from extirpation while full stabilization measures are being implemented.

<u>Species Response to the Proposed Action</u>

Over the next 30 years, *Schiedea obovata* individuals in the Kahanahaiki to Pahole and Keawapilau to West Makaleha population units will be exposed to the direct and indirect effects of training-related wildland fire in the low and very low fire risk zones. About 140 individuals occur in the low fire risk zone and 210 in the very low fire risk zone. Approximately 20 *S. obovata* are at a greater risk of fire impacts because they are growing in close proximity to the perimeter of the high fire risk zone near the Kahanahaiki Management Unit (180 m; 590 ft) (see Figure E 40). The close proximity of these plants to this historically burned area increases the risk that a future fire will spread quickly through the disturbed vegetation and encroach further into the forest edge. To minimize the risk of fires in Kahanahaiki Gulch (west of the occupied management units), the Army will construct either a 20-m (65-ft) wide firebreak, or a 200-m (656-ft) wide shaded fuelbreak in Kahanahaiki Gulch along the Kahanahaiki Management Unit perimeter. In addition, a helispot will be maintained within 500 m (1,640 ft) of the upper reaches of Kahanahaiki Gulch and a safety zone will be established within or adjacent to the management unit. These additional fire suppression measures will reduce the risk of losing all individuals of *S. obovata* in the Kahanahaiki Management Unit.

Certain weapons systems and munitions will be restricted until a fire protection system is in place for the Kahanahaiki Management Unit and expedited stabilization thresholds are achieved for at-risk taxa that occur in that management unit (see Table PD 2). No long-range weaponry will be used until expedited stabilization thresholds are achieved in all stabilization population units. Inside the action area, expedited stabilization will involve continued augmentation of *Schiedea obovata* in the Kahanahaiki to Pahole population unit, and reintroduction and augmentation in the Keawapilau to West Makaleha population unit. After expedited stabilization is complete when long-range incendiary weapons may be used at Makua, we estimate that a misfired live-fire weapon landing in forest and shrub areas will burn approximately 0.1 ha (0.3 ac) prior to fire suppression measures extinguishing the fire. Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period. However, to avoid the risk of an undetected fire, the Army will conduct an aerial survey in a helicopter for one hour post-training to check for smoke from a misfired round (see General Effects - Fire Suppression).

The *Schiedea obovata* individuals located in and adjacent to the Pahole and Upper Kapuna management units are in the very low fire risk zone. These plants could be susceptible to a misfired long-range, live-fire weapon such as the TOW. However, as with our determination for the risk of fire in the low risk area, fire detection and suppression response is designed to minimize the risk of a fire igniting in mesic forest and shrub areas.

The direct and indirect effects of non-native weeds, slugs, and ungulates will reduce the vigor, reproduction, recruitment, and survival of individual plants. *Schiedea obovata* in the action area also will be exposed to the direct and indirect impacts of non-native plants, slugs, and ungulates. Slug damage is particularly threatening to the survival and recovery of this species and the Natural Resources Staff are conducting research to help solve this widespread pest issue. Both portions of the Kahanahaiki to Pahole population unit are fenced; only the Northwest Makaleha portion of the Keawapilau to West Makaleha population unit is fenced and both population units are controlled at least partially for weeds.

<u>Conclusion</u>

Despite the ongoing exposure of *Schiedea obovata* to project wildland fire impacts, Army conservation and stewardship programs will improve this species baseline number of individuals in the action area and range-wide. Weapons restrictions, fuels management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will increase baseline numbers of *S. obovata* to meet expedited stability thresholds in three population units. However, the risk of training-related wildland fire to individuals within the action area is low and the action area population units are located in manageable habitat where ungulate and weed threats can be controlled. Thus, the overall effect of the proposed action’s stressors and subsidies will result in a net increase in the baseline number of individuals, distribution, and reproduction of *S. obovata* in and adjacent to the action area over the next 30 years. Reaching the goals outline for expedited stabilization will improve the likelihood that *S. obovata* will attain stabilization criteria and enhance its probability of persistence over the long term.

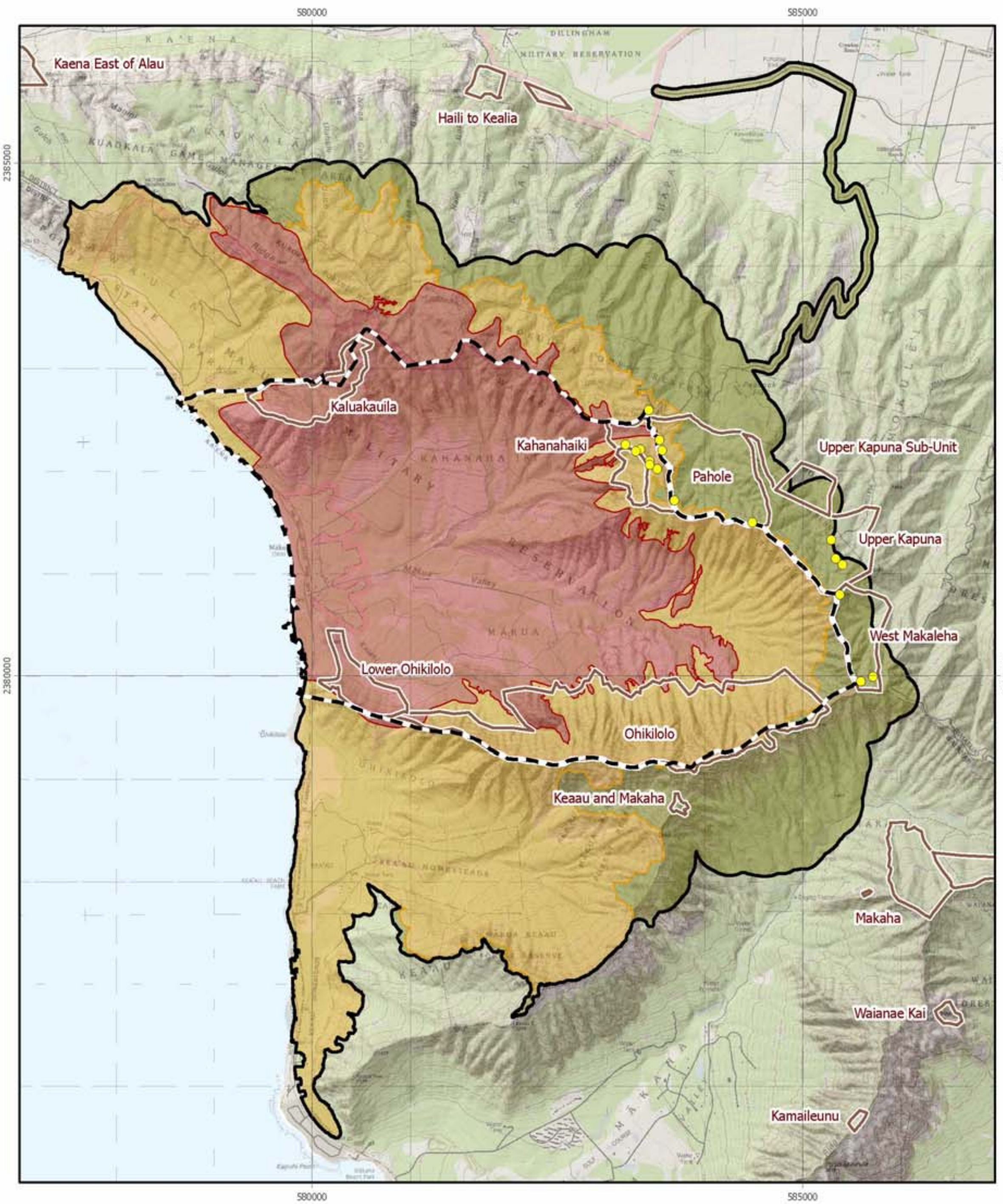


Figure E 40
Schiedea obovatum
Species observation

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION ON NON-STABILIZATION TAXA

The 11 Makua-action-area taxa listed below are not directly targeted for Army stabilization management, though they will benefit indirectly from stabilization management measures that are being implemented for other taxa. Less than 50 percent of all known individuals of each of these taxa are located within the action area; for some of the taxa, less than 1 percent is located within the action area (Table E 13 and E 14). Location within the action area by definition means these individuals are at risk of training-related wildland fire. However, this risk is reduced for non-stabilization taxa owing to their lower numbers within the action area and their overall higher abundance range-wide. Because of relatively high numbers of mature, reproducing individuals and sufficient population units at numerical thresholds for stability, stabilization was not considered necessary to protect these taxa from jeopardy due to the risk of training-related wildland fire. Taxon-specific details supporting this general analysis is contained in this section.

Abutilon sandwicense (shrub)
Bonamia menziesii (woody vine)
Ctenitis squamigera (fern)
Diellia falcata (fern)
Euphorbia haeleeleana (tree)
Lepidium arbuscula (subshrub)
Lobelia niihauensis (shrub)
Peucedanum sandwicense (perennial herb)
Schiedea hookeri (perennial herb)
Silene lanceolata (subshrub)
Spermolepis hawaiiensis (annual herb)

Status Summary of Non-stabilization Taxa

When the Makua Implementation Plan was in development, the decision to implement stabilization management measures for specific taxa was based on the likelihood the taxon would be jeopardized by military training activities and the taxon's need for additional mitigative actions to avoid the likelihood of jeopardy (Service 1999c). The following criteria were used to determine if a taxon's continued persistence is likely to be jeopardized by military training activities: (1) the species does not meet two basic conditions required for stabilization populations (i.e., each population of a taxon is naturally reproducing and at least three populations consist of the minimum number of mature, reproducing individuals); or (2) more than 50 percent of all individuals of a species occur within the Makua action area, regardless of meeting stabilization population thresholds for mature reproducing individuals. Conversely, the following criteria were implicitly used to determine if a species is not likely to be jeopardized by military training activities: (1) the species meets the two basic conditions that define stabilization populations (i.e., each population of a taxa not requiring stabilization management is naturally reproducing and at least three populations consist of minimum numbers of mature, reproducing individuals); or (2) more than 50 percent of all individuals of a taxa occur outside the Makua action area, irrespective of the number of mature, reproducing individuals.

The available data on these taxa is not sufficient to draw conclusions regarding trends in the number of individuals, distribution, and recruitment of the 11 non-stabilization taxa, or to predict quantifiable changes in the baseline conditions of these taxa over the next 30 years, with or without the proposed action.

Table E 13. Status of Non-Stabilization Taxa (U.S. Army Garrison 2006c).

Taxon	Total Number of Individuals	Percent of Total Individuals in the Action Area	Population Units With Fences	Fire Risk†
Abutilon sandwicense	425	8	2	H, L, V
Bonamia menziesii	thousands	< 1	1	H, L
Ctenitis squamigera	350	< 1	2	V
Diellia falcata	thousands	25	1	L, V
Euphorbia haeleeleana	1,500	15	2	H, L
Lepidium arbuscula	900	10	4	L
Lobelia niihauensis	2,000	25	1	L
Peucedanum sandwicense	thousands	≅1	0	--
Schiedea hookeri	400	25	3	H, L, V
Silene lanceolata	1000	< 1	1	L
Spermolepis hawaiiensis	thousands	5 %	1	H

†Fire Risk: H (high), L (low), V (very low)

Table E 14. Fire Risk Exposure for Non-Stabilization Taxa.

Taxon	Individuals Occurring In Fire Risk Zones		
	High	Low	Very Low
Abutilon sandwicense	22 (5) †	1 (<1)	12 (3)
Bonamia menziesii	10 (<1)	2 (<1)	0
Ctenitis squamigera	0	0	5 (<1)
Diellia falcate	0	1338 (20)	20 (<1)
Euphorbia haeleeleana	199 (25)	35 (7)	0
Lepidium arbuscula	0	3 (<1)	0
Lobelia niihauensis	0	150 (8)	0
Peucedanum sandwicense	0	0	0
Schiedea hookeri	92 (25)	20 (5)	6 (1)
Silene lanceolata	0	17 (2)	0
Spermolepis hawaiiensis	356 (5)	0	0

†Number of individuals occurring in fire risk zone (percent of all individuals occurring in fire risk zone).

Trends in number of individuals and distribution are difficult to discern, owing to inconsistent identification of occurrences and monitoring efforts, and no range-wide surveys have been conducted for these taxa. Seven of the taxa also occur on other islands; only *Abutilon sandwicense*, *Diellia falcata*, *Lepidium arbuscula*, and *Schiedea hookeri* are limited to population units known only on Oahu. The current known number of individuals of these 11 non-stabilization taxa state-wide ranges from a minimum of 350 to thousands of total individuals. Currently the populations of these taxa in the action area account for between 1 and 25 percent of the known individuals. All have a greater number of known, extant individuals outside the action area than inside the action area, on Oahu and/or on other islands. The range-wide population trends in abundance of most of the non-stabilization taxa appear to be stable or increasing. Although threats are not fully controlled and genetic storage is not extensive, these non-stabilization taxa are currently considered self-sustaining on a range-wide basis with limited protection and management. Because of the adequate number of mature, reproducing individuals and limited abundance in the action area, all 11 non-stabilization taxa are considered to have a moderate background risk of extinction both in the action area and range-wide. Stabilization management measures, other than those discussed in the Project Description, are considered unnecessary to ensure that the proposed Army action does not jeopardize the future existence of these species.

Analyses for Effects of the Action

Individuals of the 11 non-stabilization taxa in the action area will be exposed to training-related wildland fire and the ongoing impacts of non-native species. Effects of human disturbance (trampling) are considered minor. Life forms of these taxa include ferns, annual and perennial herbaceous plants, a woody vine, partially woody subshrubs, woody shrubs, and a small tree.

Individuals of these 11 taxa will be exposed to the direct and indirect effects of training-related wildland fire over the next 30 years, due to their occurrence within the action area in zones at high, low, or very low risk of training-related wildland fire (see Tables E 13 and E 14). All individuals and life stages are vulnerable to high and low severity fires throughout the year, depending on phenology and the time of year fire occurs. Non-stabilization taxa with individuals located in areas at high risk of fire include *Abutilon sandwicense*, *Bonamia menziesii*, *Euphorbia haeleeleana*, *Schiedea hookeri*, and *Spermolepis hawaiiensis*. These plants are likely to burn under certain conditions. Even full staffing of on-site and standby fire suppression helicopter forces will not guarantee containment of all fires. On between zero and 3.8 percent of historical potential training days analyzed, helicopter containment would have failed to contain a fire burning outside the firebreak road, if the fire had not been successfully contained before 1 p.m. A fire escaping initial attack is likely to burn into the native forest (General Effects—Fire Suppression), before additional helicopter support could arrive on-site. In addition, five non-stabilization taxa in the Kaluakauila and Lower Ohikilolo management units are particularly vulnerable to training-related wildland fire because they are located within dry, grassy areas that have burned in the past.

Plants growing outside the high fire risk zone (i.e., within the low and very low fire risk zones) are at some risk of burning as a result of training-related wildland fire ignited by a misfired or malfunctioning long-range weapons systems and munitions (tracers, AT-4 and SMAW anti-tank weapons, 2.75-caliber rockets, Javelin anti-tank missiles, and TOW missiles). These plants also have a relatively low potential to burn from spot fires of various sizes, depending on topography, vegetation cover, weather, and suppression capability. The expected fire size resulting from a misfired long-range weapon or spot fire landing within intact shrub and/or forest vegetation is about 0.1 ha (0.3 ac) with immediate fire suppression response. However, if the fire is not noticed for 48 hours, it could spread to 40.5 ha (100 ac) before containment. In addition, plants within the low fire risk zone, especially those near the high fire risk zone could burn if a fire within the high fire risk zone creeps into the edge of the low risk zone. Only a small area is expected to burn because the fire will slow down when it hits the forest/shrub habitat.

The areas exposed to training-related wildland fire and invasive species in the action area include mixed native and non-native vegetation in mesic forest, dry forest, and dry grassland/shrubland habitats. Population units of several non-stabilization taxa are at high risk of training-related wildland fire within dry, grassy habitats of the Kaluakauila, Lower Ohikilolo, and Kahanahaiki (C-Ridge vicinity) management units. Population units within mesic, forested habitats in the Kahanahaiki, Pahole, Upper Kapuna, and West Makaleha management units are generally at lower risks of fire, except in areas of alien grass encroachment. Population units in the Ohikilolo management unit along the south valley rim and in the Keaau area beyond Ohikilolo Ridge are likewise at an even lower risk of fire. Mesic conditions in upper slope forests do not preclude the incidence of fire, however, especially during prolonged drought conditions in disturbed areas with grassy understories. The spread of wildland fire from the C-Ridge area into the Kahanahaiki management unit, for example, is strongly influenced by alien grass cover. Past fires, including the 1995 and 2003 escaped prescribed burns, increased the exposure of listed plants near this area to future fires by destroying native vegetation and increasing the alien grass cover. Ten of the population units of the 11 non-stabilization taxa are located within fenced management units, but invasive weeds are not regularly controlled over all of them. Individuals under mesic forest canopy in weed control areas are fairly well protected from the spread of catastrophic fire. Other individuals in locations lacking weed control are not well protected from long-term fire encroachment into native and mixed forest.

To reduce the risk of training-related wildland fire to certain at-risk species, the Army will use certain types of weapons systems and munitions for training at Makua only after completion of specific measures to protect listed plants (see Table PD 2). Delaying the use of these weapons systems and munitions will also benefit non-stabilization species by reducing the long-range fire risk. To minimize threats, as part of the proposed action, the Army will implement conservation and stewardship programs to reduce the risk of ignition and spread of training-related wildland fire (Wildland Fire Management Plan, Integrated Natural Resource Management Plan), reintroduce and augment numbers of stabilization and at-risk taxa in the wild (Makua Implementation Plan Addendum), and improve native habitat in population units by excluding feral ungulates and controlling non-native weeds.

The risk of fire to listed species will be minimized by training restrictions, fire management, and expedited stabilization actions summarized in Table PD 2 and the Project Description. Fire minimization measures are based on required levels of helicopter staffing to contain fires before they escape the firebreak road. In addition, to reduce the fire risk to *Chamaesyce celastroides* var. *kaenana* and *Hibiscus brackenridgei* ssp. *mokuleianus* (stabilization and at-risk taxa, respectively) in the Lower Ohikilolo Management Unit, the Army will not begin any live-fire or blank-fire training until alien grass cover is removed and controlled within 3 m (9.8 ft) of these plants and to less than 20 percent cover within 20 m (65.6 ft) of all native plants. These actions also will benefit the non-stabilization taxa in these areas. Additional fuels modification within a 60-m (197-ft) swath along the inside perimeter of the south firebreak road will allow the Army to reduce the level of on-site helicopter staffing required. With these fuel modifications in place, the Army may train using small arms, demolitions, grenades, mines, simulators, and mortars and artillery, with the use of certain of these weapons systems and munitions restricted to NFDRS Green conditions. Within five to 10 years, plants growing within the Kahanahaiki and Kaluakauila management units will be protected by fuels modification and perimeter firebreaks;

these protections will benefit the non-stabilization taxa. With these management units protected from fire, and with completion of expedited stabilization of the at-risk taxa *Cyanea superba* ssp. s*uperba*, *Schiedea nuttalli*, and *Schiedea obovata*, the Army may begin training with more weapons systems and munitions under Yellow conditions instead of only under Green conditions; and begin using grenade launchers and AT-4 and SMAW weapons under Green or Yellow conditions, depending on live herbaceous fuel moisture. Expedited stabilization of 12 at-risk taxa must be complete before the Army may begin training with tracer ammunition, Javelins, and 2.75-caliber rockets. Full stabilization of all 16 stabilization taxa and all 12 at-risk taxa must be complete before the Army may begin training with TOWs. Thus, all listed species in the action area, including the 11 non-stabilization taxa, will benefit from training restrictions required until expedited stabilization is complete for all 12 at-risk species.

In general, the risk to non-stabilization taxa from military training is not high, since a small percentage (less than 1 to 25) of their total state-wide individuals occur within the action area, and an equally small percentage occurs within the high fire risk zone. Stabilization and expedited stabilization actions being implemented for other species will benefit non-stabilization species as well, so that potential impacts associated with military training activities will be minimized.

<u>Species Response to the Proposed Action</u>

The response of individuals of the 11 non-stabilization taxa to training-related wildland fire and invasive species will include the direct and indirect effects of fire injury and death, ungulate grazing and trampling, invertebrate herbivory, and alien plant competition (see General Effects). As a result, the number of mature reproducing individuals of non-stabilization taxa in the action area are not expected to decline over the next 30 years. The overall response to direct and indirect effects will be a measurable reduction in baseline numbers, distribution, and recruitment of individuals and/or entire occurrences in action area population units due to fire injury and death. Reduced fitness in plants that survive will further decrease the viability of population units through a continuing decline in baseline numbers. Without implementation of the Army's conservation and stewardship programs, these effects would lower the fitness of non-stabilization taxa in the action area by decreasing their ability to recover from disturbance and exacerbating their risk of extinction merely due to small population size alone.

We anticipate that implementation of fire management and species stabilization actions will prevent training-related declines in baseline numbers of individuals and population units of the 16 stabilization taxa and 12 at-risk taxa managed for expedited stabilization. These stabilization actions will also benefit non-stabilization taxa wherever they co-occur. Over the next 30 years, numbers of mature, reproducing individuals are expected to remain stable or increase in population units within and outside the action area. In addition, significant progress is expected over the next 30 years toward full threat control in management units. The Army and the Service will closely monitor them and revise management actions as necessary to maintain stability. Overall, the response of non-stabilization taxa to project subsidies is expected to result in measurably stable trends in individual fitness (survival, reproduction, and recruitment), stable or increased baseline numbers of mature and immature individuals within population units, and maintenance of population units within the action area and within management units outside the action area. Thus, Army conservation and stewardship programs will protect the 11 non-stabilization taxa from jeopardy over the next 30 years, increase their likelihood of maintaining stability over the long term, and enhance their probability of persistence.

The reasoning outlined above is based on information about the proposed action and the environmental baselines of the 11 non-stabilization taxa in the action area. In addition, we make general inferences from this set of circumstances according to conservation biology principles regarding small populations and from previous experience regarding threats to the conservation of native vegetation in Hawaii (see General Effects section). We also make inferences from examples of other species that are closely related or have a similar life history, and have become unstable, endangered, or extinct. For example, the genus *Schiedea* contains the highest proportion of endangered taxa of any species-rich lineage in the Hawaiian Islands (see discussion under Effects of the Action on At-Risk Taxa). The declines of several *Schiedea* species are attributed to habitat degradation by feral pigs and lack of seedling survival due to slug herbivory. Similarly, about 25 percent of lobelioid species have become extinct over the past 100 years from various causes. If not addressed, ongoing threats are likely to further imperil *Schiedea* and *Lobelia* species in the action area. We infer from such examples that non-stabilization taxa in the action area are similarly threatened with extinction, but these taxa are relatively abundant range-wide outside the action area, and thus these taxons vulnerability as a whole to the proposed action are reduced.

Conclusion

Based on the analysis above, the Service anticipates that stressors associated with training-related wildland fire, and the introduction and spread of invasive species, are likely to result in decreases in fitness of individuals and viability of population units of 11 non-stabilization taxa by reducing their number of individuals, distribution, and recruitment in the action area. Action area individuals will be exposed to high, low, and very low risks of burning as a result of training-related wildland fire over the next 30 years. The response of non-stabilization taxa to training-related wildland fire will range from the direct effects of injury and death to the indirect effects of physiological stress, increased mortality, habitat degradation, and competition with non-native species. The overall effect of training-related wildland fire and spread of invasive species will be a further decline in individual fitness, baseline numbers, and viability of population units within the action area. Individuals in action area population units represent a range of less than 1 to 25 percent of all known remaining individuals of each of these 11 non-stabilization taxa. Thus, reduced viability in action area population units will not significantly affect the range-wide status of these 11 taxa.

We develop our opinion using the best available scientific and commercial information, giving benefit of the doubt to the species if significant information gaps preclude determination of quantifiable effects. For example, the proposed action’s training-related wildland fire risk could be estimated more accurately with additional modeling to predict long-term fire frequency and encroachment into native forest, and with collection of adequate demographic data for population viability analysis of listed plants. Lacking that information, we infer from maintenance of a relatively stable number of individuals without artificial augmentation, non-stabilization taxa in the action area are self-sustaining and have a moderate background risk of extinction. We believe any additional threats, including training-related wildland fire and habitat degradation by invasive species, are likely to reduce expectation of their long-term persistence. Accordingly, we consider the existence of population units outside the action area, where they will not be exposed to training-related wildland fire, essential to the persistence of these 11 taxa in the wild. With relative robust populations and widespread distribution outside the action area, reduced viability of action area occurences is unlikely to appreciably reduce the likelihood that these species will be conserved.

Our conclusion is based on our best professional judgment of the likely response of these 11 non-stabilization taxa to both stressors and subsidies of the proposed action. Military training restrictions and conservation management for stabilization in other species will ensure that at least three population units are maintained for each taxon, including population units for each taxon outside the action area that will not be exposed to training-related wildland fire. We anticipate that Army conservation and stewardship programs, including ecosystem-level protection within stabilization management units, will benefit non-stabilization taxa in the action area and protect them from jeopardy over the next 30 years. Therefore, after reviewing the current status of the 11 non-stabilization taxa, the environmental baseline for these taxa in the action area, and the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to jeopardize the continued existence of the following 11 non-stabilization taxa in the wild by reducing their reproduction, numbers, and distribution: *Abutilon sandwicense*, *Bonamia menziesii*, *Ctenitis squamigera*, *Diellia falcata*, *Euphorbia haeleeleana*, *Lepidium arbuscula*, *Lobelia niihauensis, Peucedanum sandwicense*, *Schiedea hookeri*, *Silene lanceolata*, and *Spermolepis hawaiiensis*.

EFFECTS OF THE ACTION – *Abutilon sandwicense* (No Common Name)

Abutilon sandwicense is endemic to the island of Oahu where there are an estimated 166 mature and 258 immature individuals. Currently there are 35 or eight percent of all known *A. sandwicense* plants (2 mature, 23 immature, and 10 seedlings) in the action area (Figure E 41). These individuals are located in the Kahanahaiki, Keaau and Kaluakauila population units. Virtually all individuals of *A. sandwicense* occurring in the action area are Army reintroductions. This species also occurs at Schofield Barracks Military Reservation and the Army has developed a stabilization plan for this species pursuant to that consultation. The Oahu Implementation Plan outlines the establishment of three stabilization populations of 50 mature, reproducing individuals (U.S. Army Garrison 2005).

Species Response to the Proposed Action

Abutilon sandwicense plants in the action area are located in areas at risk of training-related wildland fire and will be exposed to the direct and indirect effects of training related wildland fires that could result in their injury or death. Twenty-two immature *A. sandwicense* plants occur in the Kaluakauila Management Unit. This management unit is surrounded by flammable grasses and shrubs established from historical fires. These *A. sandwicense* individuals are at high risk of burning in future training-related wildland fires. To date, these plants reside in a small 24.3 ha (60 ac) remnant forest that has protected them from past fires. However, as fires sweep through the area the forest edge is continually impacted and edge habitat is lost as described in General Effects – Fire Suppression. To minimize the risk to this species, the Army will implement weapons restrictions, provide improved grass mowing around the interior of the south lobe of the firebreak road, and increase fire suppression staffing. In the event that a fire threatens this site, the 20-m wide (66-ft wide) fuelbreak, with its imbedded firebreak, adjacent to the forested areas of Kaluakauila Management Unit (see Figure PD 9) will provide firefighters, including red-carded Army Natural Resources Staff and fire suppression helicopters, a high likelihood of successfully preventing fire from burning additional forest in this area.

One mature *Abutilon sandwicense* plant occurs in the low fire risk zone (Kahanahaiki) and 12 individuals occur in the very low fire risk zone (Keaau). These plants beyond the Ohikilolo Ridge in Keaau are unlikely to be burned as a result of training-related fires due to their distance (1.6 km; 1 mi) from the impact area in conjunction with fire suppression response. The probability of plants in the low and very low fire risk zones destroyed by training related fires over the next 30 years is low.

In addition to wildland fire, *Abutilon sandwicense* will also be exposed to the direct and indirect impacts of non-native plants, invertebrate pests, rats, and ungulates. These effects reduce the vigor, reproduction, recruitment, and survival of individual plants. Although this is a non-stabilization species, *A. sandwicense* will benefit from the stabilization actions implemented by the Army Natural Resources Staff such as fencing, weed control, pest management and ungulate removal. Black twig borer and the Chinese rose beetle are a significant threat to *A. sandwicense*. The Army is investigating control methods for these invertebrate pests. Thus, the overall effect of the proposed action's stressors and subsidies will result in maintenance and possibly a net increase in the baseline number of individuals, distribution, and recruitment of *A. sandwicense* in and adjacent to the action area over the next 30 years.

<u>Conclusion</u>

Military training restrictions and stabilization management for other taxa at Makua will benefit *Abutilon sandwicense* in Makua. In addition, as a stabilization species for the training at Schofield Barracks Military Reservation, three population units, including Kaawa to Puulu and Makaha Makai, outside of the action area, will be implemented. At Makua, weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire destroying *A. sandwicense* in the action area. The potential damage or loss of *A. sandwicense* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua and Oahu Implementation Plans. Fencing and ungulate control, weed control, invertebrate pest research, and fire suppression measures are expected to result in increased numbers of *A. sandwicense* at Makua.

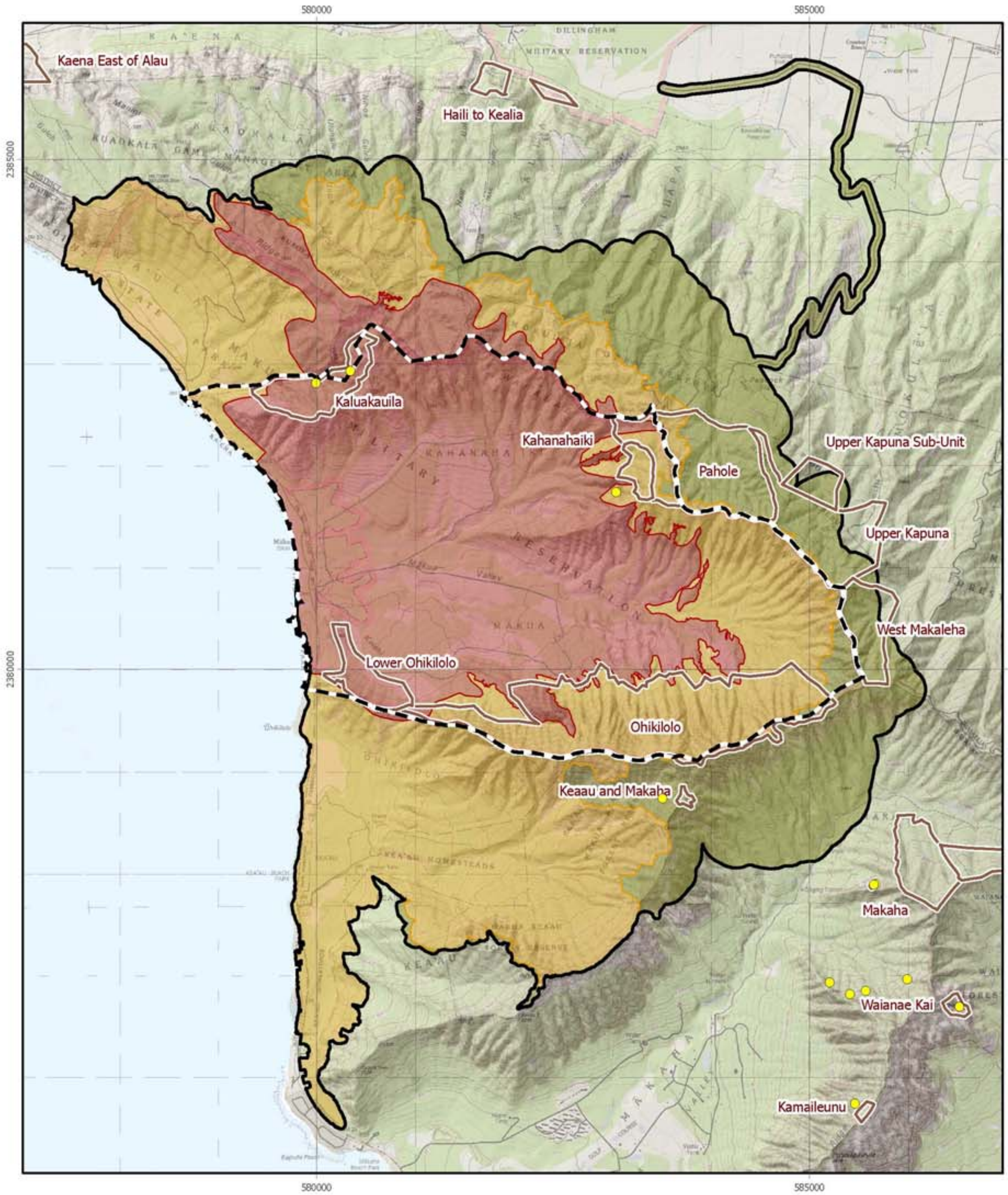


Figure E 41
Abutilon sandwicense

Species observation

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Bonamia menziesii* (No Common Name)

There are 12 individuals (all mature) of *Bonamia menziesii* in the action area located in the Makua, Keaau and Kaluakauila population units (Figure E 42). There are several thousand individuals of *B. menziesii* State-wide, however, there are only about 60 individuals on Oahu. Twelve individuals in the Makua action area represent less than one percent of all known *B. menziesii* plants and approximately 20 percent of the individuals on Oahu. This is a non-stabilization species due to its abundance and distribution outside of the Makua action area.

<u>Species Response to the Proposed Action</u>

Bonamia menziesii plants in the action area are at risk of injury or death from training-related wildland fire. Approximately 10 mature individuals occur in the Kaluakauila Management Unit located in the high fire-risk area. The Kaluakauila Management Unit is located in a xeric area surrounded by flammable grasses and shrubs established from historical fires, and therefore, *B. menziesii* individuals are at risk of burning in future training-related wildland fires. The majority of these plants reside in a small 24.3 ha (60 ac) remnant forest that has protected them to date. However, as fires sweep through the area the forest edge is continually impacted and edge habitat is lost as described in the General Effects. To minimize the risk to this species, the Army will implement weapons restrictions, provide improved grass mowing around the interior of the south lobe of the firebreak road, and increase fire suppression staffing. These requirements make it unlikely that a fire will escape containment due to initial attack and fire suppression resources, particularly prior to implementation of Column C weapons restrictions (see Table PD 2). In the event that a fire threatens this site, the 20-m (66-ft) wide fuelbreak, with its imbedded firebreak, adjacent to the forested areas of Kaluakauila Management Unit (see Figure PD 9) will provide firefighters, including red-carded Army Natural Resources Staff and fire suppression helicopters, a high likelihood of successfully preventing fire from burning additional forest in this area. Prior to implementation of Column C weapons restrictions, the 10 *B. menziesii* in the Kaluakauila Management Unit will be provided additional protection from fire, either with the completion of additional fuel modification work, or with selected stabilization measures (see General Effects).

One *Bonamia menziesii* in the high risk Lower Ohikilolo Management Unit could be destroyed in a training related fire, however, the Natural Resources Staff control invasive grasses in this unit thus reducing the risk of fire ignition or fire spread in this area. The other individual is located in the low fire risk area on Ohikilolo Ridge and is somewhat protected from wildland fire due to topography and distance from the impact area. Stabilization provides beneficial resource management actions such as ungulate exclusionary fencing, rat baiting, and weed management. For example, recruitment of *Bonamia menziesii* has been observed in the Kaluakauila fence exclosure where in 2005 five new plants were observed (U.S. Army Garrison 2006c).

<u>Conclusion</u>

There are very few naturally occurring individuals of *Bonamia menziesii* within the action area and there are thousands of mature, reproducing individuals range-wide, therefore this species has a low risk of background extinction range-wide. The loss of *B. menziesii* in the action area would reduce the range-wide distribution of this species. However, weapons restrictions, fire suppression helicopter staffing, implementation of suppression actions, to include the new fuelbreaks and firebreaks at Makua, will minimize the risk of a fire directly impacting *B. menziesii* in the action area. In addition, the potential damage or loss of *B. menziesii* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for other species pursuant to the Makua Implementation Plan and the Makua Implementation Plan Addendum. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Bonamia menziesii* Critical Habitat

There are two critical habitat units within the Makua action area, that, taken together, comprise approximately two percent (28 ha; 69 ac) of the total State-wide critical habitat for *Bonamia menziesii* (see Figure E 42). One hundred percent of unit B is within the high fire risk zone. Three percent of unit A is in the high fire risk zone. Together, these units were designated to provide habitat for the conservation of one population of at least 300 mature, reproducing individuals of *B. menziesii* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, steep slopes or level ground in dry or mesic forest in open or closed canopy. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within dry or mesic forest in open or closed canopy. It is estimated that only one-quarter of the critical habitat within the Makua training action area has a native plant component of more than 75 percent, indicating a high degree of invasive plant encroachment (K. Kawelo, pers. comm. 2004; 68 FR 35950). Although degraded, these units still support individuals of *B. menziesii* and provide habitat that is necessary to meet the recovery goals for this species. Portions of critical habitat unit B burned in 2003, removing approximately 2.4 ha (6 ac) of habitat (G. Enriques, pers. comm. 2003). This loss of native habitat expedites invasion and growth of non-native plant species that can outcompete the native plants. In the absence of habitat management, additional fires from future training activities will add to the degradation of these critical habitat units.

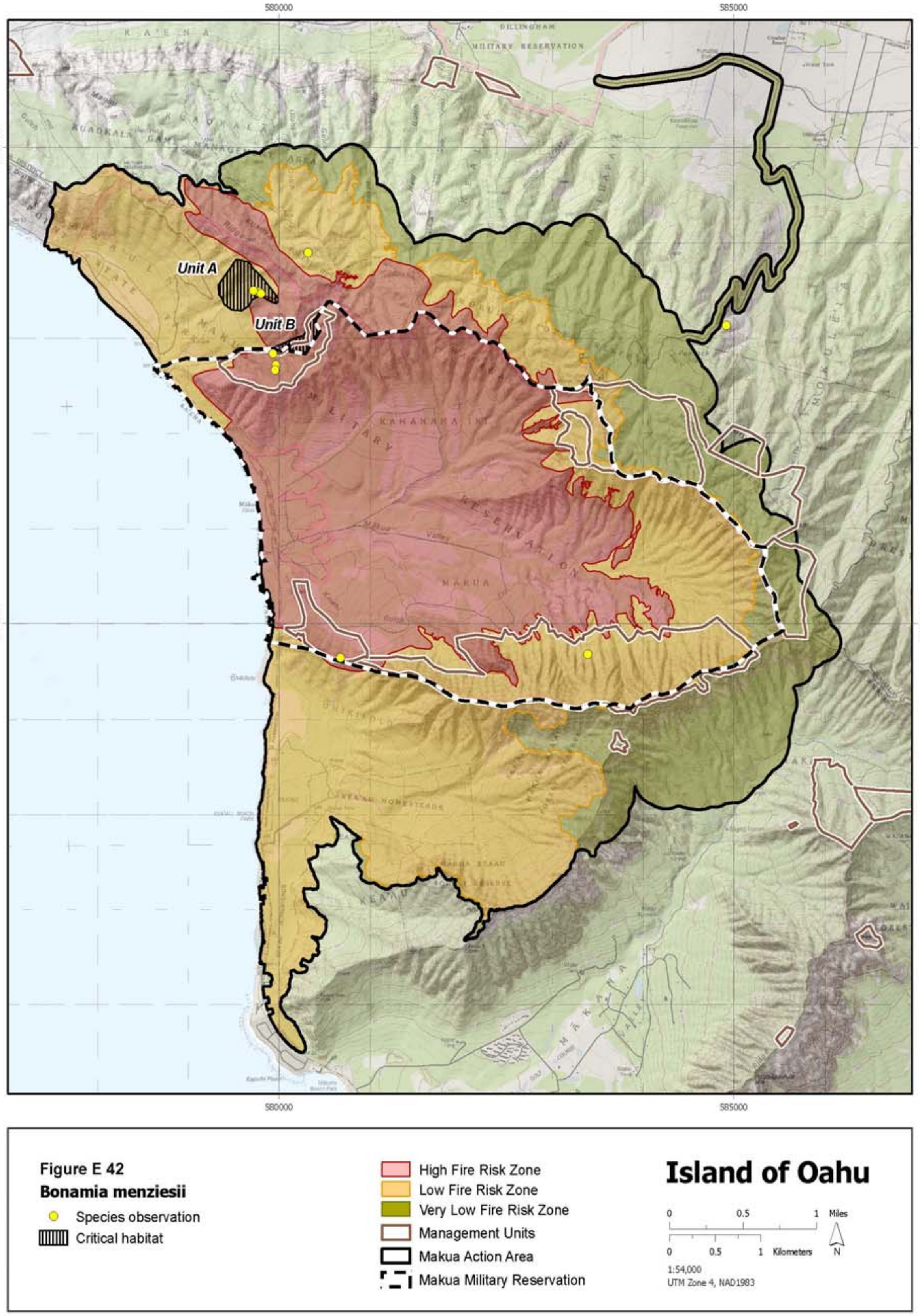
Critical habitat unit A (21 ha; 51 ac) is north of the Kaluakauila Management Unit. This critical habitat unit abuts the high fire risk zone, and, due to the proximity of this critical habitat to the potential fire source, there is a risk that a fire started in the high fire risk zone could escape the firebreak road and move north, impacting this unit. The risk of fire in this xeric grassland habitat is high due to the surrounding *Panicum maximum* grassland which is highly flammable and can increase frequency and size of wildland fires (Beavers et al 1999). A prescribed burn in 2003 encroached within 0.4 km (0.3 mi) of critical habitat unit A (G. Enriques, pers. comm. 2003). The consequence of this burn is the loss of vegetative primary constituent elements and encroachment of non-native grasses and shrubs. This increased fuel load increases the risk of future fires, and each subsequent fire removes additional native habitat, thus setting up a cycle of burn/invasive plant intrusion. The loss of vegetative primary constituent elements within this unit reduces its ability to provide for the conservation of a portion of one population of *B. menziesii* pursuant to recovery goals. To reduce the risk of fire to listed species and sensitive habitats, the Army has prepared a fire management plan for the Kaluakauila Management Unit. Implementation of this plan will reduce the risk of fire due to the construction of a fuel modification zone between the impact area and the management unit. The fuel modifications in and around the Kaluakauila Management Unit will provide a buffer between the impact area and critical habitat unit A and reduce the probability that fire will reach this critical habitat unit. In addition, this management unit is currently fenced and the Army is working to reduce non-native plants within the exclosure. This action will further reduce the risk of wildland fire from encroaching into and past the management unit.

Critical habitat unit B is located within the high fire risk zone as described above; the risk of a fire in this xeric grassland habitat is high. Sixty-five percent (5 ha; 12 ac) of this critical habitat unit is in the Kaluakauila Management Unit. A portion of this critical habitat unit was impacted during the 2003 prescribed burn (G. Enriques, pers. comm. 2003). The loss of primary constituent elements within this critical habitat unit would remove its ability to provide habitat, together with critical habitat unit A, for one population of *Bonamia menziesii*. The fire management plan for the Kaluakauila Management Unit, and the implementation of several fire abatement measures within and around this management unit, will help reduce the probability that critical habitat unit B will burn. In addition to reducing fire threat, the removal of ungulates and non-native invasive plant species within this management unit enhances the conservation value of critical habitat unit B. The remaining critical habitat (2 ha; 6 ac) outside of the management unit is buffered from the impact area by the management unit. The fuel modification activities, plus other conservation measures implemented by the Army for species stabilization, will also reduce the risk of fire to the portion of the critical habitat outside of the management unit.

To reduce the negative impacts to these two critical habitat units from any fire that escapes the firebreak road and burns critical habitat, the Army has committed to revegetate burned areas of critical habitat with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species and by controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the revegetation process, the ability of these units to provide habitat essential for the conservation of one population of *Bonamia menziesii* will be retained in the long-term.

Conclusion

The two critical habitat units for *Bonamia menziesii* in the Makua action area are located in the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the Kaluakauila Management Unit. In addition, fuel reduction within the management unit will further buffer critical habitat units A and B from fire. The portion of critical habitat unit B that is within Kaluakauila Management Unit will be managed to improve its baseline quality pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *B. menziesii* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *B. menziesii* and will allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *B. menziesii.*


580000
585000
2385000
2380000
Unit A
Unit B
Figure E 42
Bonamia menziesii
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Ctenitis squamigera* (Pauoa**)**

Less than one percent, or three individuals, of *Ctenitis squamigera* are located in Makua in the Ohikilolo Management Unit (U.S. Army Garrison 2005c) (Figure E 43). There are approximately 100 individuals of *C. squamigera* located outside of the Makua action area in the East Makaleha population unit. This is a non-stabilization species due to its abundance and distribution outside of the Makua action area.

Species Response to the Proposed Action

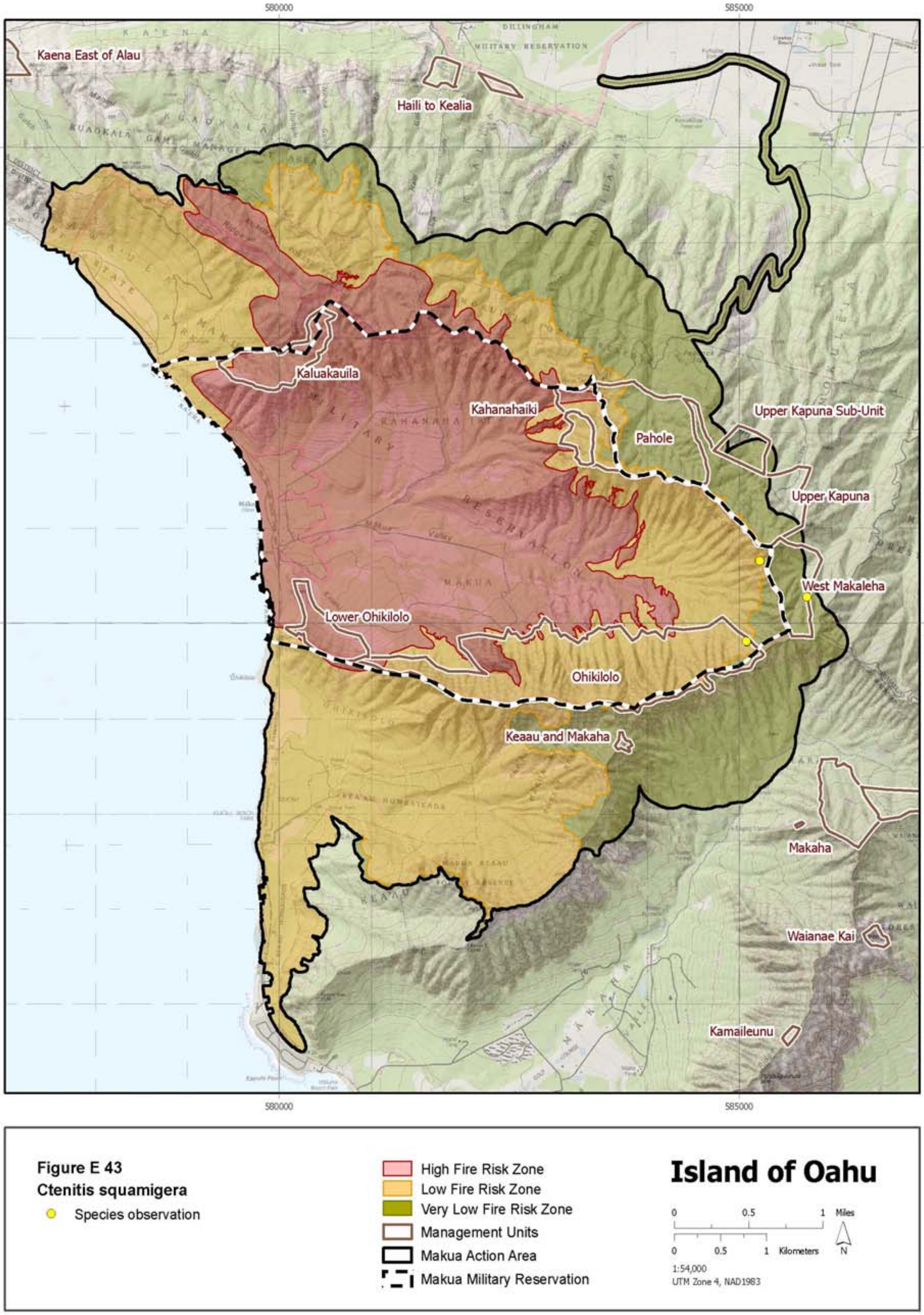
Ctenitis squamigera in the action area are at risk of injury or death from training-related wildland fire. Approximately three individuals occur in the Ohikilolo Management Unit located in the low fire risk area. A wildland fire could spread into Ohikilolo Ridge from the valley floor, start on the ridge from a misfired long-range, live-fire weapon such as the TOW, or start from a spot fire resulting from an intense grass fire in the valley. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Since the vegetation is on the cliff face of Ohikilolo is sparse the risk of a large fire is low if fire suppression is quickly deployed (see General Effects - Fire Suppression). The risk of a wildland fire spreading from the valley floor (impact area) up the ridge is very low due the fire suppression measures that will be enacted that will impede fire spread prior to impacting the top of the Ohikilolo ridgeline. In addition, the spread of a wildland fire would be limited due to the discontinuous fuels on the cliffs.

Ctenitis squamigera will benefit from management efforts directed towards stabilization taxa. For instance, the known individuals of *C. squamigera* within the action area occur within a fenced unit benefiting from ungulate exclosure and weed removal. Another beneficial action will be the fencing of the East Makaleha Management Unit in 2008 where 100 individuals of *C. squamigera* reside. Furthermore, this species is represented in an *ex situ* collection of 30 ungerminated spores in micropropagation (Harold L. Lyon Arboretum) (Service 2005b).

Conclusion

There are three individuals of *Ctenitis squamigera* within the action area out of approximately 350 individuals range-wide. Weapon restrictions, fire suppression helicopter staffing, implementation of suppression actions, to include the new fuelbreaks and firebreaks at Makua, will minimize the risk of a fire directly impacting *C. squamigera* in the action area. In addition, the potential damage or loss of *C. squamigera* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for other species pursuant to the Makua Implementation Plan and the Makua Implementation Plan Addendum. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's ecosystem management.

This species has a moderate background risk extinction range-wide, though military training is unlikely to affect the species persistence. However, the fact that there are very few individuals of *Ctenitis squamigera* in the action area suggests there is a significant risk that this species will be extirpated from the action area, though not due to military actions. It should be noted that the Army plans to fence the East Makaleha management unit in 2008. There are currently 100 individuals in this unit. Fencing will remove browsing pressures from alien ungulates and should thus increase this species abundance in the management unit. Weed removal and rat baiting, in management units the Army currently manages, will also increase the abundance of this species. Elsewhere across the species current range there are populations with a moderate number of individuals, making the likelihood this species will be driven to extinction less likely than the probability it will be extirpated from the action area. Overall, the subsidies of the proposed action will outweigh the stressors and may improve its likelihood of persistence over the long term.


580000
585000
2385000
2380000
Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 43
Ctenitis squamigera
Species observation
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Diellia falcata (Puu Pane)*

There are approximately 1,265 *Diellia falcata* in the action area located in the Kaluakauila, Kahanahaiki, Pahole, Upper Kapuna Sub-Unit, West Makaleha, and Ohikilolo management units (U.S. Army Garrison 2005c) (Figure E 44). Approximately 500 additional *D. falcata* grow in the Waianae Mountains, and State-wide there are approximately six-thousand *D. falcata* (U.S. Army Garrison 2006d). *Diellia falcate* is a short-lived perennial fern which grows at mid and upper elevations in the Waianae Mountains. Inside the action area, there are many immature individuals, suggesting natural recruitment is occurring and senescent individuals are being replaced by naturally occurring immature individuals (U.S. Army Garrison 2006d).

Species Response to the Proposed Action

The proposed action of increased Army training with long-range, incendiary weapons could result in injury and death of *Diellia falcata* individuals in the action area. Although the ferns all occur in the low and very low fire risk zones, they may be burned in a fire ignited on the ridge by a misfired long-range, live-fire weapon such as the TOW, or by from a spot fire resulting from an intense grass fire in the valley. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48 hr period (see General Effects - Fire Suppression).

The 55 *D. falcata* growing on C-Ridge and adjacent to Kaluakauila Management Unit grow within 100 m (328 ft) of the historically burned areas (see General Effects – Fire Suppression). Targeted grass control on C-Ridge will reduce the fire risk to the *D. falcata*, but these plants may be burned in a large fire. There are approximately 1,250 individuals in the Kahanahaiki management unit. This unit is located in the low fire risk zone. However, the dominant overstory vegetation in this area is Kukui trees and fires would spread slowly in this area. To minimize the risk of fires to the 1,250 *D. falcata* and other taxa in Kahanahaiki Gulch, the Army will construct either a 20-m (65-ft) wide firebreak, or a 200-m (656-ft) wide shaded fuelbreak in Kahanahaiki Gulch along the Kahanahaiki Management Unit perimeter. In addition, a helispot will be maintained within 500 m (1,640 ft) of the upper reaches of Kahanahaiki Gulch and a safety zone will be established within or adjacent to the management unit so that skilled NWCG-qualified fireline supervisors and firefighters, including red-carded Army Natural Resources Staff, can safely staff the outplanting site when fire threatens the gulch area. There are approximately 1,200 individuals of *D. falcate* in fenced units in the action area which will benefit from ungulate exclosure and weed removal (Susan Ching, pers. comm. 2007).

Conclusion

Because fewer than 20 percent of the total known *Diellia falcata* plants occur within the action area and thousands occur State-wide, this species has a moderate background risk of extinction. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *D. falcata* in the action area. The potential damage or loss of *D. falcata* individuals from fire will be offset by the ongoing efforts of the

Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan Addendum. Fencing and ungulate control, weed control, slug and snail control research, and genetic storage are expected to result in an increase in abundance of *D. falcata*. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Diellia falcata* Critical Habitat

There is one critical habitat unit within the Makua action area, comprising two percent (14 ha; 34 ac) of the designated critical habitat for *Diellia falcata*. It is located in the northeastern portion of the action area, outside of the high fire risk area (see Figure E 44). This critical habitat unit was designated to provide habitat for the conservation of one population of 300 mature, reproducing individuals of *D. falcata* (68FR 35950). The primary constituent elements essential for this species include, but are not limited to, deep shade or open understory on moderate to moderately steep slopes and gulch bottoms in diverse mesic forest. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within deep shade or open understory in diverse mesic forest. It is estimated that more than 80 percent of the critical habitat is located in forest with greater than 50 percent native plant cover (K. Kawelo, pers. comm. 2004; 68 FR 35950). This indicates that this critical habitat unit is somewhat degraded due to non-native plant encroachment. In the absence of habitat management, fires from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

There is a risk that if a fire started in the impact area, it could move east and impact this unit or a misfired round could ignite outside of the firebreak road and burn into this critical habitat. The loss of primary constituent elements within this unit would remove its ability to provide for the conservation of one population of *Diellia falcata*. However, this risk is reduced due to the beneficial resource management actions conducted by the Army, pursuant to the Makua Implementation Plan, in the management units; by the low flammability of the surrounding vegetation (diverse mesic forest); and by spatial separation from the impact area. A total of 11 ha (27 ac), or 77 percent, of critical habitat is in management units. Two ha (5 ac) are in the Upper Kapuna Management Unit and 10 ha (25 ac) are in the West Makaleha Management Unit. The Army plans to complete fencing for the West Makaleha Management Unit and to fence the Upper Kapuna Management Unit. Ungulates will be removed from these fenced areas. The Army is working to reduce non-native plants in both of these management units, thereby reducing their fuel load and the risk of fire. In addition, the Army is conducting rat control in the West Makaleha Management Unit to reduce their impact on listed and associated native plants. The removal of ungulates and non-native plants from within the West Makaleha and Upper Kapuna Management Units enhances the conservation value of this critical habitat unit. The remaining critical habitat (46 ha; 113 ac) outside of the management units is separated from the impact area by both management units. The fuel modification activities, plus other threat reduction measures implemented by the Army for species stabilization, will further reduce the risk of fire to the portion of the critical habitat outside of the management units.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The re-vegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the re-vegetation process, the ability of these units to provide habitat essential for the conservation of one population of *Diellia falcata* will be retained in the long-term.

Conclusion

The critical habitat unit for *Diellia falcata* in the Makua training action area is located in the low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to fuel reduction within the management units, the low flammability of the surrounding diverse mesic forest, and by spatial separation from the impact area. The portion of critical habitat that is within Upper Kapuna Management Unit and the West Makaleha Management Unit will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *D. falcata* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *D. falcata* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat.

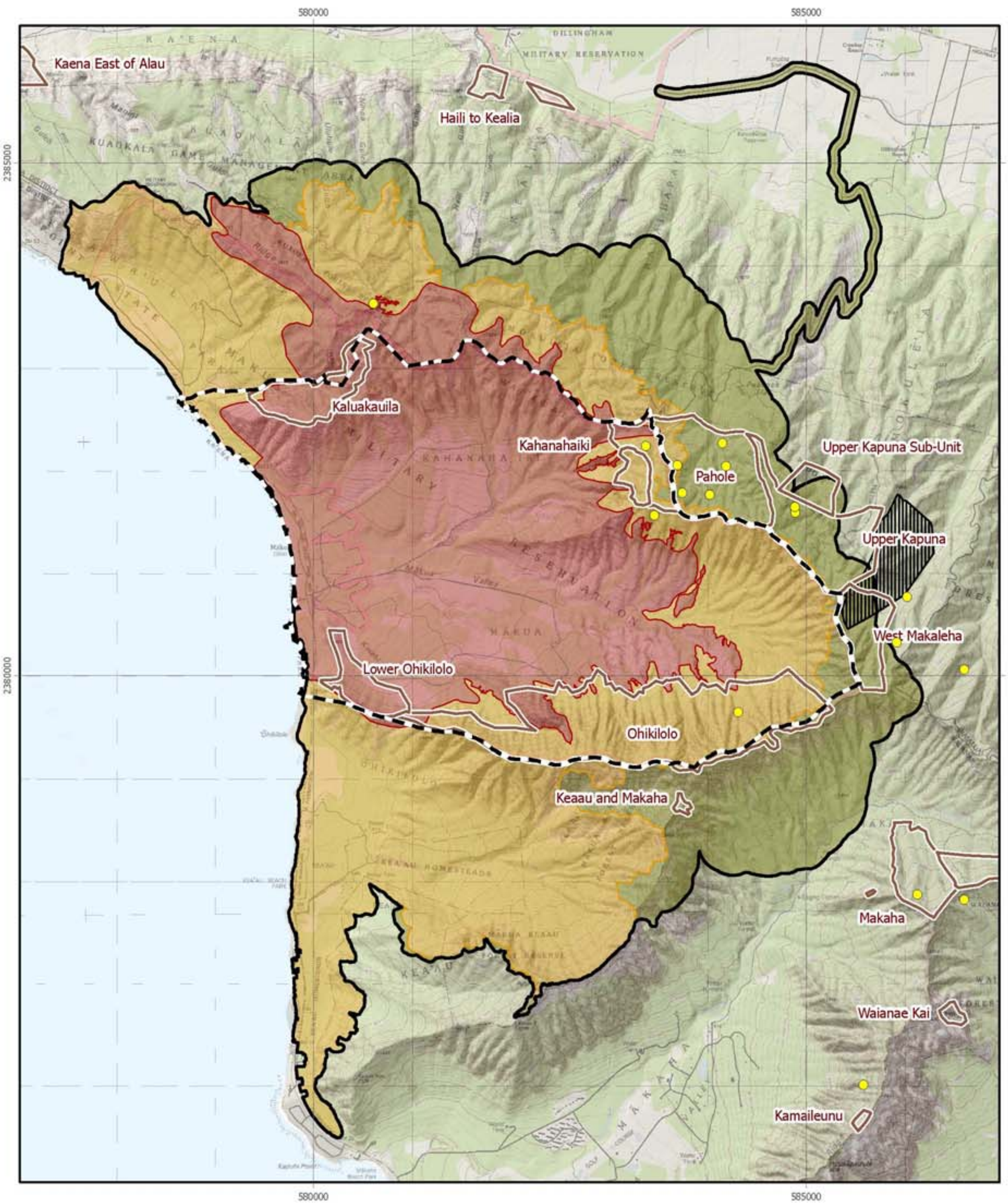


Figure E 44
Diellia falcata

Species observation
Critical habitat

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Euphorbia haeleeleana* (Akoko)

Of the estimated 934 to 1,094 range-wide individuals of *Euphorbia haeleeleana*, approximately 260 individuals are located in the Makua action area in the Kahanahaiki (34), Kaluakauila (199) and Keawaula (27) population units (Figure E 45). The *E. haeleeleana* trees in Makua represent a substantial portion of the total number of individuals (approximately 28 percent) range-wide. The largest population on Oahu (350 individuals) is located outside the action area within the Palikea Gulch to Kaumokunui population unit.

Species Response to the Proposed Action

The majority of the *Euphorbia haeleeleana* individuals, approximately 199 plants, are located in the Kaluakauila Management Unit in the high fire risk zone where they are at risk of injury or death from a training-related wildfire. The Kaluakauila Management Unit is located in a xeric area surrounded by flammable grasses and shrubs established from historical fires, and therefore, *E. haeleeleana* individuals are at high risk of burning in future training-related wildland fires. The majority of these plants reside is a small 24.3 ha (60 ac) remnant forest that has protected them to date. However, as fires sweep through the area the forest edge is continually impacted and edge habitat is lost as described in the General Effects – Fire Section. To minimize the risk to this species, the Army will implement weapons restrictions, provide improved grass mowing around the interior of the south lobe of the firebreak road, and increase fire suppression staffing. These requirements make it unlikely that a fire will escape containment due to initial attack and fire suppression resources, particularly prior to implementation of Column C weapons restrictions (see Table PD 2). In the event that a fire threatens this site, the 20-m wide (66-ft wide) fuelbreak, with its imbedded firebreak, adjacent to the forested areas of Kaluakauila Management Unit (see Figure PD 9) will provide firefighters, including red-carded Army Natural Resources Staff and fire suppression helicopters, a high likelihood of successfully preventing fire from burning additional forest in this area. Prior to implementation of Column C weapons restrictions, the 199 *E. haeleeleana* in the Kaluakauila Management Unit will be provided additional protection from fire, either with the completion of additional fuel modification work, or with selected stabilization measures.

The other 34 individuals of *Euphorbia haeleeleana*, outplanted in the Kahanakaiki Management Unit, occur in the low fire risk zone. There is a risk that a training related fire could impact some of these individuals due to their proximity to the high fire zone. However, to minimize the risk of fire to the plants growing on the edge and below the Kahanahaiki Management Unit (see Figure E 45), the Army will construct and maintain a new 40-m (131-ft) wide fuelbreak (see Figure PD 7 - section 3.1.4.1).

Despite the ongoing exposure of *Euphorbia haeleeleana* to live-fire training impacts, it is our opinion that Army conservation and stewardship programs will benefit this species. Approximately 230 individuals of *E. haeleeleana* are located in management units at Makua. These individuals benefit from the management activities conducted by the Army Natural Resources Staff as discussed in the General Effects.

<u>Conclusion</u>

A majority of the individuals of *Euphorbia haeleeleana* grow in xeric lowland habitat on Makua that make these plants very susceptible to training-related wildfire. If all plants are killed, this would result in a loss of 28 percent of the total range-wide individuals of this species which would have a detrimental impact to the ability of this species to persist for the long-term. To minimize the risk of fire to the plants in the action area, weapons restrictions, fire suppression staffing, and fuel modifications will be completed. Prior to implementation of Column C weapons restrictions, the 199 *E. haeleeleana* in the Kaluakauila Management Unit will be afforded additional protection from fire, either with the completion of additional fuel modification work, or with selected stabilization measures. Stabilization/expedited stabilization management measures for other taxa will benefit all species on an ecosystem wide basis over the long term as fences are constructed and other threats (rats, invertebrate pests and weed management) are abated. Proposed weapons restrictions, fuels management, fire suppression, stabilization actions including invasive species control will maintain or potentially allow for the increase of baseline numbers for *E. haeleeleana*.

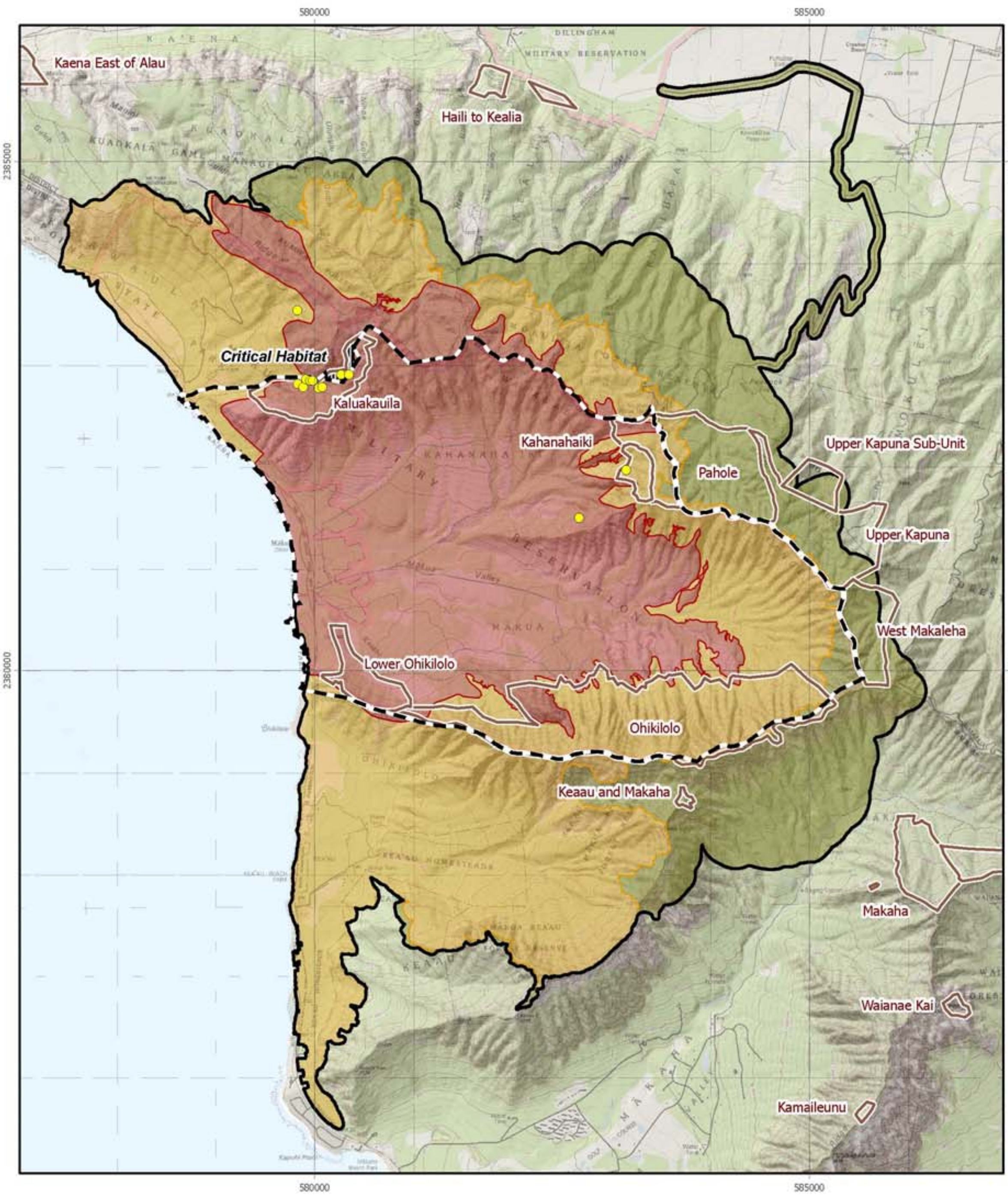
Effects of the Action on *Euphorbia haeleeleana* Critical Habitat

There is one critical habitat unit within the northwestern portion of the Makua action area, comprising one percent (4 ha; 11 ac) of the total critical habitat for *Euphorbia haeleeleana* (see Figure E 45). This unit is found in the high fire risk zone and was designated to provide a portion of the habitat necessary for the conservation of one population of at least 300 mature individuals of *E. haeleeleana* (68FR 35950). The primary constituent elements essential for this species include, but are not limited to, dry forest dominated by *Diospyros* sp. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within dry forest dominated by *Diospyros* sp. It is estimated that the entire critical habitat is located in an area with greater than 75 percent native plant cover, indicating a slight encroachment of non-native plants within this critical habitat unit (K. Kawelo, pers. comm. 2004; 68 FR 35950). This critical habitat unit provides a portion of the habitat necessary for the expansion of the present population of *E. haeleeleana* in order to meet the recovery goals for this species. It is likely that the 2003 prescribed burn impacted a portion of this unit (G. Enriques, pers. comm. 2003). Fire removes the vegetative primary constituent elements, and non-native plant species subsequently outcompete the native plants so that natural recruitment is precluded. In the absence of habitat management, additional fires from future training actions will add to the degradation of this critical habitat unit.

This critical habitat unit is approximately 1 km (0.6 mi) from the impact area and is almost entirely (95 percent) within the Kalaukauila Management Unit. Due to the proximity of this unit to the fire source, there is a risk that a fire started in the impact area could move north and impact this unit. The risk of fire in this critical habitat unit is high. The surrounding vegetation consists of highly flammable non-native grasses and forest (see Figure E 5). The 2003 prescribed burn impacted a portion of this critical habitat unit (see Figures E 3 and E 23) (G. Enriques, pers. comm. 2003). The consequences of this fire event are the encroachment of non-native grasses in the critical habitat and increased risk of future fires in the unit. The loss of vegetative primary constituent elements in this unit would remove its ability to provide habitat for the conservation of a portion of one population of *E. haeleeleana*. To reduce the risk of fire to listed species and sensitive habitats, the Army has prepared a fire management plan for the Kaluakauila Management Unit. Implementation of this plan will reduce the risk of fire due to the construction of a fuel modification zone between the impact area and the management unit. Fuel modifications in and around the Kaluakauila Management Unit will provide a buffer between the impact area and critical habitat unit. In addition, this management unit is currently fenced and the Army is working to reduce non-native plants within the enclosure. The removal of ungulates and non-native invasive plant species within this management unit enhances the conservation value of the critical habitat unit.

Conclusion

The critical habitat unit for *Euphorbia haeleeleana* in the Makua action area is located in the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the Kaluakauila Management Unit. In addition, fuel reduction within the management unit will further buffer the critical habitat unit from fire. Pursuant to the Makua Implementation Plan, the critical habitat unit will be managed to improve its baseline quality in the Kaluakauila Management Unit. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *E. haeleeleana* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *E. haeleeleana* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *E. haeleeleana.*


580000
585000
2385000
2380000
Kaena East of Alau
Haili to Kealia
Critical Habitat
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu

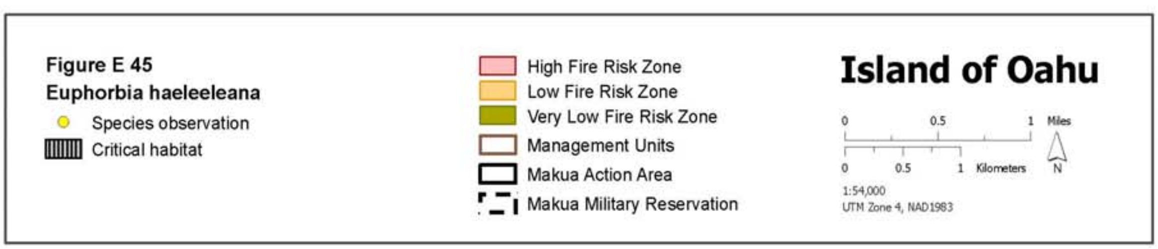


Figure E 45
Euphorbia haeleeleana
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Lepidium arbuscula* (Pepperwort; Anaunau)

There are approximately 50 individuals of *Lepidium arbuscula* in the action area (five percent) located in the Ohikilolo, Keeau, Lower Makua and Kuaokala population units (Figure E 46). This species is an Oahu endemic and presently there are an estimated 900 extant individuals island-wide. Due to the abundance and distribution of this species outside of the action area, the Army is not responsible for species stabilization pursuant to criteria as outlined in the Makua Implementation Plan (Makua Implementation Team 2003).

<u>Species Response to the Proposed Action</u>

Lepidium arbuscula favors the dry to mesic habitat in Makua where all 50 individuals are located in the low fire risk zone. Individuals of *L. arbuscula* will be exposed to the direct and indirect effects of training related wildland fire that could result in their injury or death. The result of a wildland fire could be the direct loss of any plants in the path of the fire. *Lepidium arbuscula* is distributed in four to five population units from the north of Makua (north of Kaluakauila Management Unit), to the east in the Kahanahaiki Management Unit, and to the south in the Ohikilolo Management Unit. A wildland fire could spread into any of these areas from the valley floor, ignite on a ridgeline from a misfired long-range, live-fire weapon such as the TOW, or start from a spot fire resulting from an intense grass fire in the valley. Some individuals of *L. arbuscula* are located near the high fire risk zone (i.e., located closer to the valley floor) and are therefore more susceptible to a training-related fire. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression). It is extremely unlikely that all, or even a significant portion, of the 50 *L. arbuscula* plants will be lost in training-related wildland fires. It is our opinion that the risk of fire destroying more than one population of *L. arbuscula* is very low due to their scattered distribution and this loss will not significantly hinder the future existence of this species.

In addition to wildland fire, *Lepidium arbuscula* will also be exposed to the direct and indirect impacts of non-native plants, slugs, rats, and ungulates. These effects reduce the vigor, reproduction, recruitment, and survival of individual plants. Although this is a non-stabilization species, *L. arbuscula* will benefit from the stabilization actions implemented by the Natural Resources Staff such as fencing, weed control, pest management and ungulate removal. Thus, the overall effect of the proposed action's stressors and subsidies will result in maintenance and possibly a net increase in the baseline number of individuals, distribution, and recruitment of *L. arbuscula* in and adjacent to the action area over the next 30 years.

<u>Conclusion</u>

Only five percent of all known *Lepidium arbuscula* individuals occur within the action area. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire impacting *L. arbuscula* in the action area. The potential damage or loss of *L. arbuscula* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for this species pursuant to the Makua Implementation Plan and the Makua Implementation Plan Addendum. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

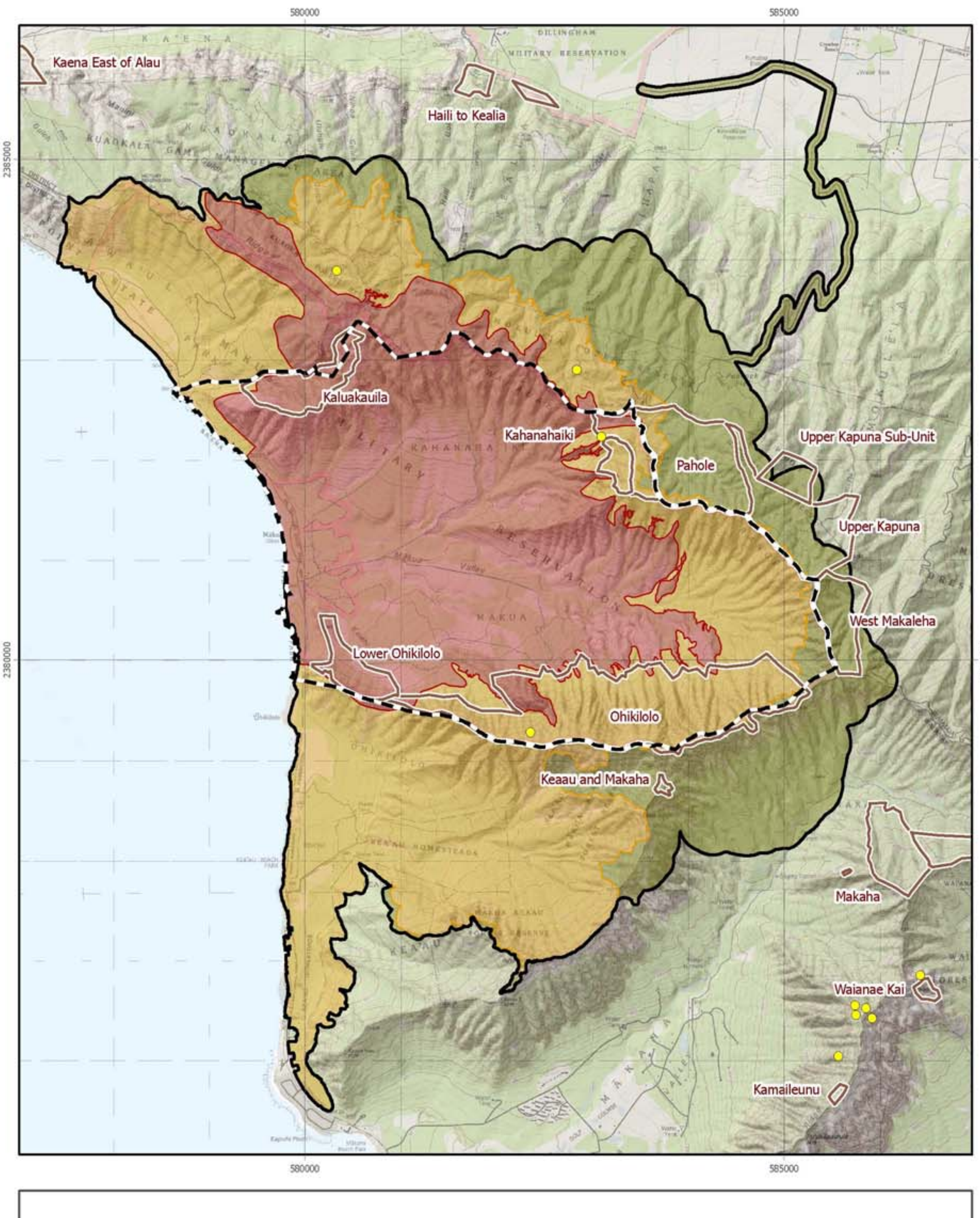


Figure E 46
Lepidium arbuscula
Species observation

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Lobelia niihauensis* (No Common Name)

There are estimated to be between 1,700 and 3,700 individuals of *Lobelia niihauensis* distributed on several islands. Approximately 475 individuals occur in the action area in the Ohikilolo, Kahanahaiki, Eastern Makua and Keaau population units (Figure E 47). This represents between 12 and 30 percent known individuals State-wide. There is a substantial population on Kauai (between 960 and 2,900 individuals in 14 population units). Due to the abundance and distribution of this species, the Army is not responsible for stabilization of *L. niihauensis.* The focus of this species-specific analysis is to assess the risk of loss of individuals from a training related wildland fire.

Species Response to the Proposed Action

Individuals of *Lobelia niihauensis* will be exposed to the direct and indirect effects of training related wildland fire that could result in their injury or death. The result of a wildland fire would be the direct loss of any plants in the path of the fire. Indirect effects of wildland fire include heat, erosion and post-fire recruitment of non-native, competitive plants (see General Effects). The vast majority (over 400; U.S. Army Garrison 2005) of the *L. niihauensis* plants in Makua are located in the low fire risk zone within the Ohikilolo Management Unit.

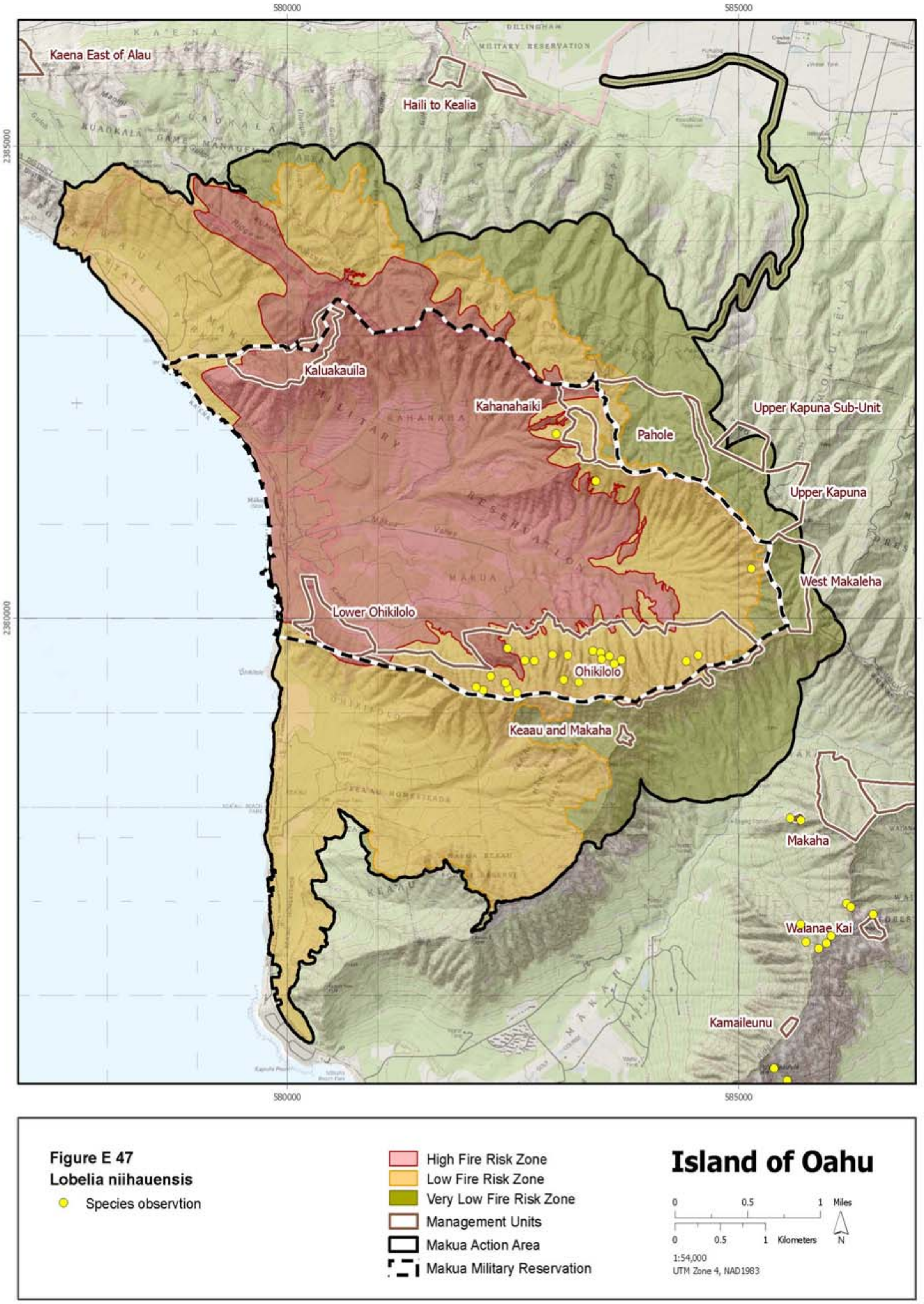
The risk assessment for this species includes several factors including distribution of *Lobelia niihauensis* within the action area, distance from the high fire zone and impact area. A wildland fire could spread into Ohikilolo Ridge from the valley floor, start on the ridge from a misfired long-range, live-fire weapon such as the TOW, or start from a spot fire resulting from an intense grass fire in the valley. Some individuals of *L. niihauensis* are located near the high fire risk zone (i.e., located closer to the valley floor) and are therefore more susceptible from a training-related fire. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression). The risk of a wildland fire spreading from the valley floor (impact area) up the ridge is very low due the fire suppression measures that will be enacted to impede fire spread. In addition, the spread of a wildland fire will be limited due to the discontinuous fuels on the cliffs along Ohikilolo Ridge, and therefore, the risk of affecting all plants in one fire in this area is very low.

There are approximately 60 individuals in the Keaau Management Unit. This management unit is in the very low fire risk zone. The Keaau Management Unit will be fenced in 2009. Fencing and other ecosystem level management efforts inside the management units will benefit this species. It is extremely unlikely that all, or even a significant portion, of the 475 *Lobelia niihauensis* plants in the action area will be lost in training-related wildland fires, although some plants may be damaged or lost due to fires resulting from Army training activities.

However, based on the available data, numbers of individuals appear to be relatively stable from the time the species range-wide abundance was first estimated in 1991. There is a significant number of naturally occurring seedlings and immature individuals both inside and outside of the action area, suggesting there is natural recruitment. There are three occurrences of *Lobelia niihauensis* outside the Makua action area that are represented by more than 50 mature reproducing individuals (U.S. Army Garrison 2005). In addition, a boundary ridgeline fence protects a major part of the Ohikilolo Management Unit, and goats have been virtually eradicated from this portion of Makua.

Conclusion

Military training restrictions and stabilization management implemented for other taxa will benefit this species. Weapons restrictions, fire detection, fire suppression helicopter staffing, and implementation of suppression actions by skilled NWCG-qualified fireline supervisors will minimize the risk of a fire burning *Lobelia niihauensis* in the action area. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's fencing, rat control, weed removal and ecosystem management will benefit this species. Overall, the minimal risk of impact from training-related actions and the beneficial resource management activities to be conducted at Makua outweigh the Army training-related risk to this species.


Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
580000
585000
2385000
2380000
Figure E 47
Lobelia niihauensis
Species observtion
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Peucedanum sandwicense* (Makou)

There are approximately 25 individuals of *Peucedanum sandwicense* in the action area (U.S. Army Garrison 2005) out of an estimated population of over 1,150 individuals (Figure E 48). Only about two percent of *P. sandwicense* individuals occur in the action area, thus this species is not a stabilization species. The 25 individuals of *P. sandwicense* are exposed to the suite of threats as described and analyzed in the General Effects section of this Biological Opinion**.**

It is difficult to determine accurately the abundance of *Peucedanum sandwicense* since this species is a short-lived perennial herb and fluctuations in numbers are normal depending upon environmental conditions. Variation in rainfall along with other abiotic and biotic factors may account for these fluctuations. However, based on the low number of individuals in the action area the likelihood of this species persisting in Makua over time is low (Brook et al 2006). Then again, seeds of *P. sandwicense* may persist in the soil and there may be increased occurrences of this species if suitable environmental conditions arise. The abundance of *P. sandwicense* on Oahu appears to be relatively stable from the time when the species range-wide abundance was first estimated in 1991. On Kauai there are over 1,000 individuals, suggesting *P. sandwicense* is self-sustaining on that island.

Species Response to the Proposed Action

Peucedanum sandwicense will be exposed to the direct and indirect effects of a training-related wildland fire. The risk is very low for this species due to its location in the Keaau Management Unit located on the southern slope of the Ohikilolo Ridgeline. The Keaau Management Unit will be fenced in 2009, which will allow for ecosystem-level management efforts inside the management unit. Fencing and other threat abatement actions conducted by the Army Natural Resources Staff such as rat baiting and non-native plant removal will benefit the remaining *P. sandwicense* plants and residual seedbank and could lead to an increase in baseline numbers, distribution, and reproduction of *P. sandwicense* in and adjacent to the action area over the next 30 years.

Conclusion

There are approximately 25 individuals of *Peucedanum sandwicense* within the action area, and it is estimated that there are several thousand mature, reproducing individuals offsite. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *P. sandwicense* in the action area. Overall, the risk of loss of individuals of this species to training related wildland fires is very low (see General Effects) and the proposed action of fencing in 2009 to preclude grazing pressure will benefit this species over time.

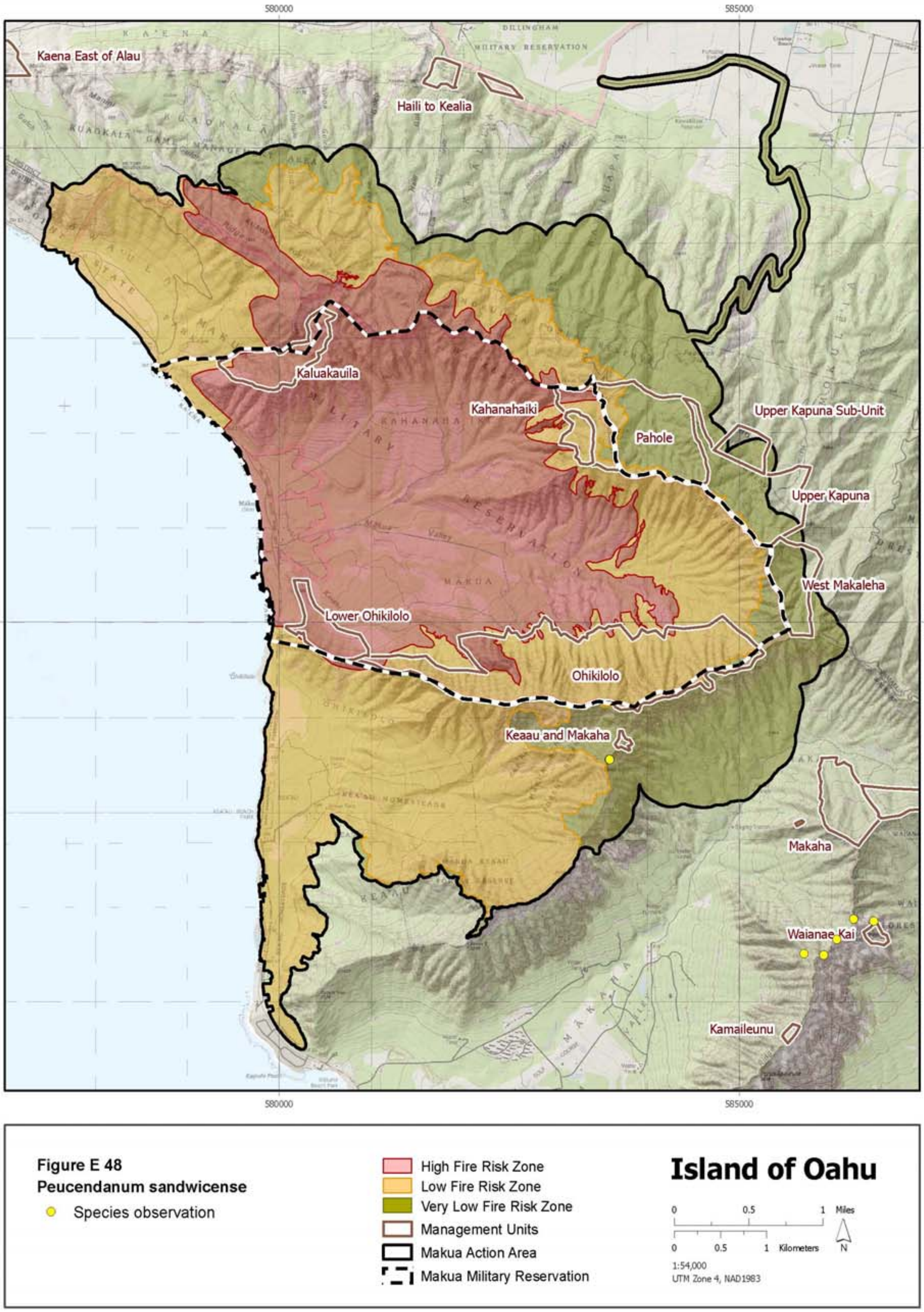


Figure E 48
Peucendanum sandwicense
Species observation

EFFECTS OF THE ACTION – *Schiedea hookeri* (No Common Name)

Schiedea hookeri is endemic to the Waianae Mountains on Oahu with an estimated range-wide abundance of between 400 and 500 individuals. In the Makua action area, there are approximately 130 individuals (90 mature and 40 seedlings) located in the Kahanahaiki, Kaluakauila, Keaau and Ohikilolo population units (Figure E 49). Therefore, about 25 to 30 percent of all known *S. hookeri* individuals occur within the action area. This species is a non-stabilization species due to overall distribution and abundance.

<u>Species Response to the Proposed Action</u>

Schiedea hookeri plants in the action area are at risk of injury or death from training-related wildland fire. Approximately 52 mature individuals occur in the Kaluakauila Management Unit located in the high fire-risk area. The Kaluakauila Management Unit is located in a xeric area surrounded by flammable grasses and shrubs established from historical fires, and therefore, *S. hookeri* individuals are at high risk of burning in future training-related wildland fires. The majority of these plants reside is a small 24.3 ha (60 ac) remnant forest that has protected them to date. However, as fires sweep through the area the forest edge is continually impacted and edge habitat is lost as described in General Effects – Fire Suppression. To minimize the risk to this species, the Army will implement weapons restrictions, provide improved grass mowing around the interior of the south lobe of the firebreak road, and increase fire suppression staffing. These requirements make it unlikely that a fire will escape containment due to initial attack and fire suppression resources, particularly prior to implementation of Column C weapons restrictions (see Table PD 2). In the event that a fire threatens this site, the 20-m (66-ft) wide fuelbreak, with its imbedded firebreak, adjacent to the forested areas of Kaluakauila Management Unit (see Figure PD 9) will provide firefighters, including red-carded Army Natural Resources Staff and fire suppression helicopters, a high likelihood of successfully preventing fire from burning additional forest in this area. Prior to implementation of Column C weapons restrictions, the 50 *S. hookeri* in the Kaluakauila Management Unit will be provided additional protection from fire, either with the completion of additional fuel modification work, or with selected stabilization measures (see General Effects – Fire Suppression).

There are approximately 20 mature individuals just south of the Kahanahaiki Management Unit (see Figure E 49). These individuals are in the low fire risk zone and are located on a ridge top less than 10 m (30 ft) from the high fire risk zone. There is a risk the individuals in this occurrence will be impacted by training related wildland fires especially due to their proximity to more flammable fuels located in the high fire risk zone. To minimize the risk of fire to the plants growing below the Kahanahaiki Management Unit, the Army will construct and maintain a new 40-m (130-ft) wide fuelbreak (see Figure PD 7 - section 3.1.4.1).

There are approximately four *Schiedea hookeri* in the Ohikilolo Management Unit and 12 in the Keaau Management Unit in areas of low to very low fire risk. A wildland fire could ignite from a training-related misfired long-range, live-fire weapon such as the TOW, or from a spot fire spread by high winds. However, both of these populations are somewhat protected due to their distance from the impact area or the topography of the Ohikilolo ridgeline. Fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could permit these fires to burn more than 40 ha (100 ac) in a 48 hour period (see General Effects - Fire Suppression).

Schiedea hookeri is also exposed to the suite of threats as described and analyzed in the General Effects. Although this species is not a stabilization species, many individuals are located in fenced management units (Kaluakauila) or protected by the ridgeline fence on Ohikilolo. These plants benefit from reduced ungulate herbivory and some level of weed management. *Schiedea hookeri* will benefit from the stabilization actions implemented by the Army Natural Resources Staff in the action area. Thus, the overall effect of the proposed action's stressors and subsidies will result in maintenance and possibly a net increase in baseline number of individuals, distribution, and reproduction of *S. hookeri* in and adjacent to the action area over the next 30 years.

Conclusions

There are only between 400 and 500 individuals of *Schiedea hookeri* remaining in the Waianae Mountains; therefore, this species has a high background risk of extinction due to stochastic events. Prior to implementation of Column C weapons restrictions, the 50 *S. hookeri* in the Kaluakauila Management Unit will be afforded additional protection from fire, either with the completion of additional fuel modification work, or with selected stabilization measures. Military training restrictions and stabilization management for other taxa will decrease the likelihood this species will be extirpated from the action area. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *S. hookeri* in the action area. The potential damage or loss of *S. hookeri* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions. Therefore, based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's management actions.

Effects of the Action on *Schiedea hookeri* Critical Habitat

There are two critical habitat units within the Makua action area, comprising three percent (30 ha; 75 ac) of the total critical habitat for *Schiedea hookeri* (see Figure E 49). Close to 100 percent (6 ha; 14 ac) of the critical habitat in the action area is in an area of high fire risk. Critical habitat unit A, which is currently occupied, was designated to provide habitat for the conservation of a portion of one population of *S. hookeri*. Critical habitat unit B, which is unoccupied, is part of a larger 717 ha (1,771 ac) unit that extends outside of the action area and was designated to provide habitat for the conservation of two populations of *S. hookeri*. Each population will be comprised of at least 300 mature, reproducing individuals in order to meet the recovery goals for this species (68FR 35950). The primary constituent elements essential to the species include, but are not limited to, slopes, cliffs or cliff bases, rock walls, or ledges in diverse mesic or dry lowland forest often dominated by *Metrosideros polymorpha* (ohia), *Diospyros sandwicensis* (lama), or *Diospyros hillebrandii* (lama). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within diverse mesic or dry lowland forest often dominated by ohia or lama. It is estimated that about one-half of the critical habitat is located in an area with 25 to 50 percent native plant cover, and the remainder is located in an area with 50 to 75 percent native plant cover (K. Kawelo, pers. comm. 2004; 68 FR 35950; 68 FR 35950). This indicates that half of the critical habitat is degraded due to non-native plant encroachment.

Portions of critical habitat unit A have been impacted by past fire events, which further diminishes the conservation value of this habitat. Fire removes the vegetative primary constituent elements, and natural recruitment is precluded by aggressive, faster-growing non-native plants species. In the absence of habitat management, additional fires from future training actions could add to the degradation of these critical habitat units by removing the remaining vegetative primary constituent elements.

Critical habitat unit A (5 ha; 12 ac) is in the northwestern portion of the action area and entirely within the Kaluakauila Management Unit. This unit is approximately 1 km (0.6 mi) from the impact area and the risk of fire in this xeric grassland habitat is high. The 2003 prescribed burn impacted a portion of critical habitat unit A (G. Enriques, pers. comm. 2003). Due to the close proximity of this unit to the fire source, there is a risk that a fire started in the impact area could move north and impact this critical habitat unit. The fire risk is increased due to the surrounding vegetation that is dominated by *Panicum maximum* (see Figure E 5), which is highly flammable and can increase frequency and size of wildland fires (Beavers et al 1999). The loss of the vegetative primary constituent elements of this unit would remove its ability to provide a portion of the habitat necessary for the conservation of one population of *Schiedea hookeri*. To reduce the risk of fire to listed species and sensitive habitats, the Army will prepare a fire management plan for the Kaluakauila Management Unit. Implementation of this plan will reduce the risk of fire due to the construction of a fuel modification zone between the impact area and the management unit. Fuel modification will buffer the Kaluakauila Management Unit from fires that spread outside the impact area and in turn help reduce the probability that critical habitat unit A will burn. In addition, this management unit is currently fenced and the Army is working to reduce non-native plants within the exclosure. The removal of ungulates and non-native invasive plant species within this management unit enhances the conservation value of this critical habitat unit.

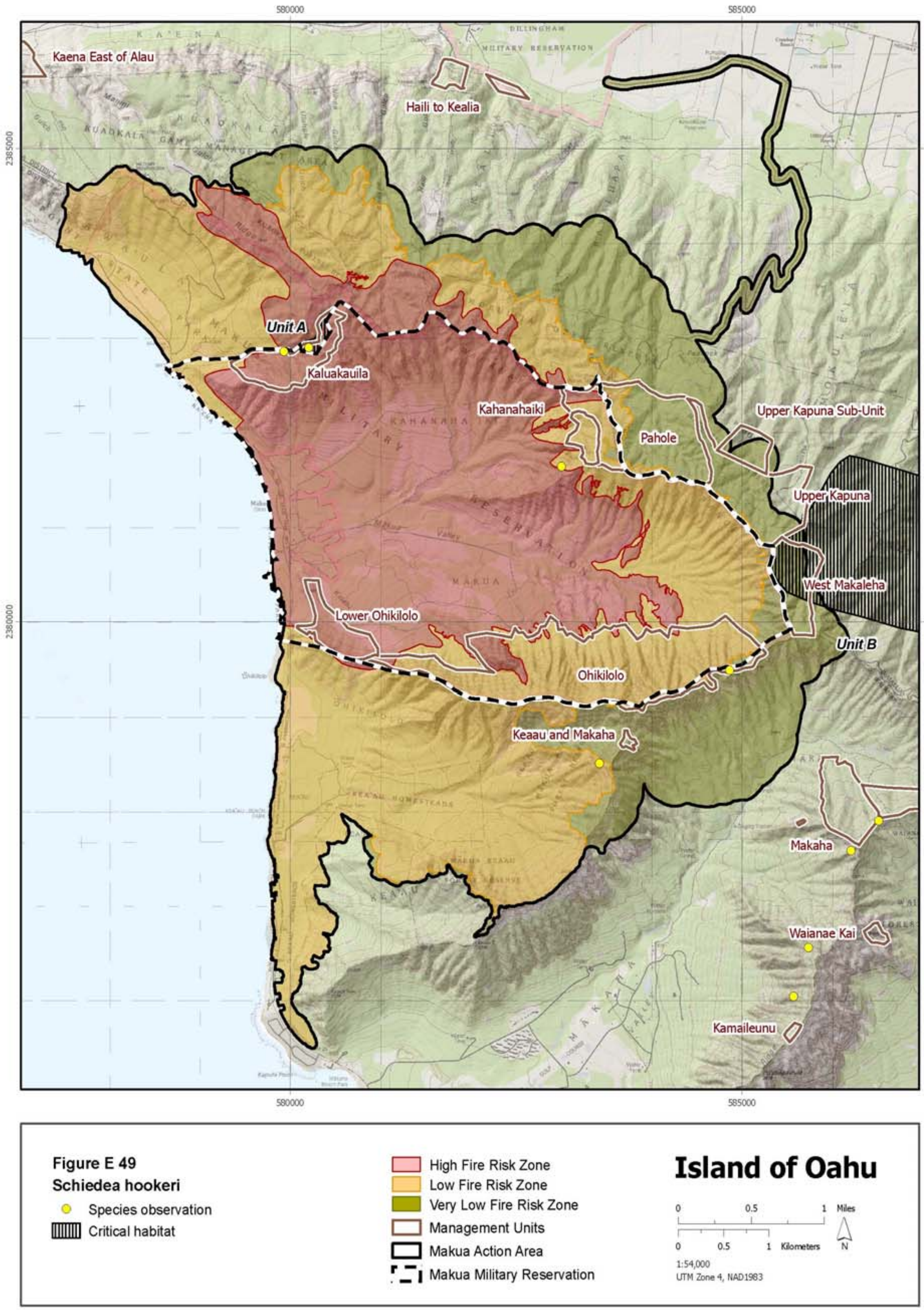
Critical habitat unit B (20 ha; 49 ac) is in the northeastern portion of the action area, almost entirely in an area of low and very low fire risk. Only 0.8 ha (2 ac) are in a high fire risk area. There is a risk that a fire started in the impact area could move east and impact this unit or that a misfired round could ignite outside of the firebreak road and burn into this critical habitat. The loss of vegetative primary constituent elements within this unit would remove its ability to provide for the conservation of a portion of two populations of *Schiedea hookeri*. However, this risk is reduced due to the beneficial resource management actions conducted by the Army, pursuant to the Makua Implementation Plan, in the management unit; the low flammability of the surrounding vegetation (mesic forest); and spatial separation from the impact area. Approximately 25 ha (approximately 61 ac), or 80 percent, of the critical habitat is in management units. Two tenths of an acre is located in the Upper Kapuna Management Unit and 20 ha (49 ac) are in the West Makaleha Management Unit. Less than one-half of one hectare

(0.47 ha; 1.2 ac) is in the Central and East Makaleha Management Unit. The Army plans to complete the West Makaleha Management Unit fence and to fence the Upper Kapuna Management Unit. Ungulates will be removed from these fenced areas. The removal of ungulates and non-native plants from within the West Makaleha and Upper Kapuna management units enhances the conservation value of both critical habitat units. The Army is working to reduce non-native plants in both of these management units, thereby reducing their fuel load and the risk of fire. In addition, the Army is conducting rat control in the West Makaleha Management Unit to reduce their impact on listed and associated native plants. The remaining critical habitat (6 ha; 14 ac) outside of the management units is separated from the impact area by the management units. The fuel modification activities plus other threat reduction measures implemented by the Army for species stabilization will further reduce the risk of fire to this portion of the critical habitat.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of these critical habitat units during the revegetation process, the ability of these units to provide habitat essential for the conservation of *Schiedea hookeri* will be retained in the long-term.

<u>Conclusion</u>

Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire to the critical habitat in the Kaluakauila Management Unit will be reduced due to the construction of a fuel modification zone between the impact area and this management unit. In addition, fuel reduction within the management units will further buffer both critical habitat units from fire. The critical habitat in unit A and the portions of critical habitat unit B in management units will be managed to improve their baseline quality pursuant to the Makua Implementation Plan. Without this management, these critical habitat units would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). The Service considered this continued risk of modification to *S. hookeri* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *S. hookeri* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *S. hookeri.*


Kaena East of Alau
Haili to Kealia
Unit A
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Unit B
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
580000
585000
2385000
2380000
Figure E 49
Schiedea hookeri
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Silene lanceolata* (No Common Name)

The 24 individuals of *Silene lanceolata* in the action area occur along the ridgeline of the Ohikilolo Management Unit. There are between 600 and 1,000 individuals of *S. lanceolata* on Oahu, Hawaii and Molokai. Roughly 15 percent of *S. lanceolata* individuals on Oahu are found within the action area with approximately 2 percent of the range-wide population located in the action area (Figure E 50). In addition to individuals found in the action area on Oahu, *S. lanceolata* also occurs in the Waianae Kai Population Unit.

The number of *Silene lanceolata* individuals in the action area has declined since the first survey was conducted in 1996. In 1996, there were approximately 40 mature individuals and today there are only 11 mature individuals. It is difficult to assess changes in the abundance *S. lanceolata* outside of the action area, as estimates of total number of individuals has varied greatly since the species range-wide abundance was first estimated in 1991. The focus of this species-specific analysis is to assess the risk of loss of individuals from a training-related wildland fire for this non-stabilization species.

Species Response to the Proposed Action

All of the *Silene lanceolata* individuals are located in the Ohikilolo Management Unit, in the low fire risk zone where they are at risk of injury or death from a training-related wildland fire. A wildland fire could spread into Ohikilolo Ridge from the valley floor, start on the ridge from a misfired long-range, live-fire weapon such as the TOW, or start from a spot fire resulting from an intense grass fire in the valley. However, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). In addition, the risk of a wildland fire spreading from the valley floor (impact area) up the ridge is very low due the fire suppression measures that will be enacted to impede fire spread (see General Effects – Fire Suppression). The spread of a wildland fire will be limited by the discontinuous fuels on the cliffs, and therefore, the risk of affecting all plants in one fire in this area is very low.

Silene lanceolata occur behind a ridgeline fence that precludes grazing by feral ungulates. In addition, this species will benefit from the activities conducted by the Army Natural Resources Staff as they implement stabilization measures for other plant taxa. Therefore, fencing and other ecosystem level management efforts inside the management units will benefit this species. Thus, the overall effect of the proposed action's stressors and subsidies will result in maintenance and possibly a net increase in the baseline number of individuals, distribution, and recruitment of *S. lanceolata* in and adjacent to the action area over the next 30 years.

Conclusion

There are very few individuals of *Silene lanceolata* within the action area and there are between 600 and 1,000 individuals range-wide, therefore, even the worse case scenario of extirpation from the action area would not be a significant loss for this species. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning *S. lanceolata* in the action area. Stabilization/expedited stabilization management measures for other taxa will benefit all species on an ecosystem-wide basis over the long-term as fences are constructed and other threats (rats, invertebrate pests and weed management) are abated. Weapons restrictions, fuels management, fire suppression, stabilization actions including invasive species control will maintain or potentially allow for the increase of baseline numbers for *S. lanceolata*. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

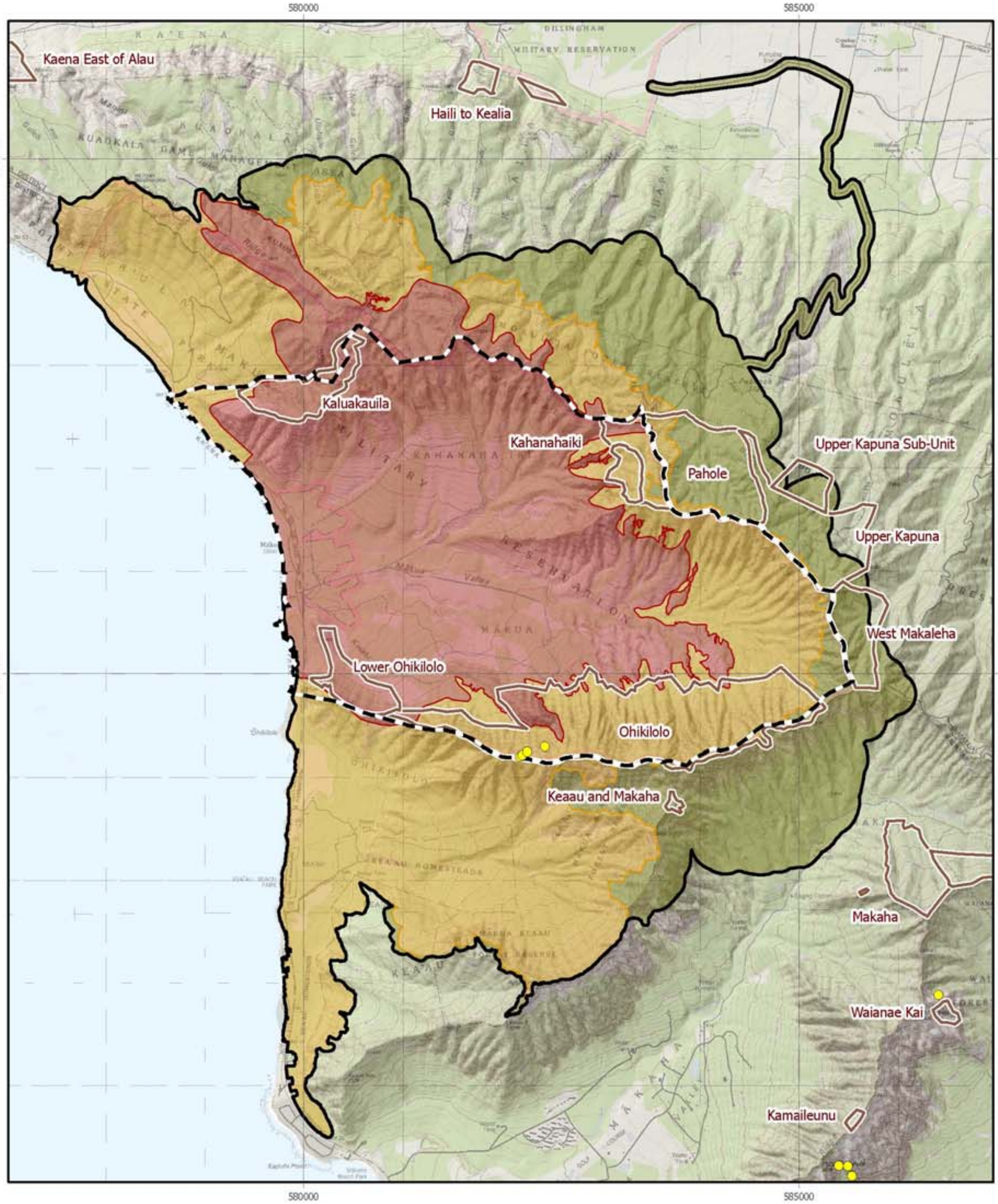


Figure E 50
Silene lanceolata

- Species observation

- High Fire Risk Zone
- Low Fire Risk Zone
- Very Low Fire Risk Zone
- Management Units
- Makua Action Area
- Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Spermolepis hawaiiensis* (No Common Name)

Spermolepis hawaiiensis is an annual and its numbers fluctuate significantly from year to year, depending on climatic conditions and other unknown factors. Most recent survey efforts located 356 *S. hawaiiensis* in the action area in Ohikilolo, Lower Ohikilolo, and Kaluakauila management units (Figure E 51). Depending on environmental conditions, several thousand to over ten thousand *S. hawaiiensis* are found in a given year throughout this species' multi-island range (Service 2003b and U.S. Army Garrison 2005b). Thousands of plants are known to grow on Daimond Head on Oahu, and Army Natural Resources Staff recently discovered 200 *S. hawaiiensis* in the Kamaileunu Management Unit, outside the action area (Susan Ching pers. comm.). *Spermolepis hawaiiensis* is also found on Kauai, Molokai, Lanai, West Maui, and the island of Hawaii. Approximately five percent of all *S. hawaiiensis* individuals occur within the action area.

Species Response to the Proposed Action

Spermolepis hawaiiensis plants in the action area are located in the Ohikilolo and Lower Ohikilolo management units (354 individuals) and Punapohaku population unit (2 individuals), in the high fire risk zone. Sites where most of these plants occur are within the perimeters of many historic wildland fires, ignited by the public (along Farrington Highway) and the Army (see General Effects – Fire Suppression). Fire threat to this species is lower than for perennial plants in these areas, because *S. hawaiiensis*' vegetative growth occurs in the winter wet season when fire risk is lower. Intense fires associated with live-fire training may impact this species' soil seed bank in the summer. New weapons restrictions, improved grass mowing around the interior of the south lobe of the firebreak road, and increased fire suppression staffing requirements are likely to reduce the fire risk to these plants. Future long-term management unit-level fire protection systems will reduce fire risk to the individuals in Ohikilolo, Lower Ohikilolo, and Kamaileunu management units. Army wildland fire suppression support to the State and City and County will reduce fire threats to the Kamaileunu population unit, outside the action area. All *S. hawaiiensis* in the action area will benefit from ungulate exclosure and weed removal and the Kamaileunu fence and ungulate removal are scheduled to be completed by the Army in 2008. Thus, the overall effect of the proposed action's stressors and subsidies will result in maintenance and possibly a net increase in baseline numbers, distribution, and reproduction of *S. hawaiiensis* in and adjacent to the action area over the next 30 years.

Conclusion

Only a small percentage of *Spermolepis hawaiiensis* individuals occur within the action area; there are thousands of mature, reproducing individuals in approximately ten occurrences range-wide. Therefore this species has a low background risk extinction. Weapons restrictions, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified fireline supervisors, and new fuelbreaks and firebreaks will minimize the risk of a fire burning S. *hawaiiensis* in the action area. The potential damage or loss of S. *hawaiiensis* individuals from fire will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement ecosystem management actions within the management units. Fencing and ungulate control, weed control, and wildland fire suppression will reduce threats to this species. Based on our analysis of the effects of the actions outlined in the Project Description including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits of the Army's stabilization actions and ecosystem management.

Effects of the Action on *Spermolepis hawaiiensis* Critical Habitat

There is one critical habitat unit within the Makua action area, with 0.7 ha (1.7 ac), of the total State-wide critical habitat for *Spermolepis hawaiiensis* (see Figure E 51). The critical habitat unit is located in the southwestern portion of the action area within the high fire risk area. This unit was designated to provide a portion of the habitat for the conservation of one population with a minimum of 300 mature, reproducing individuals of *S. hawaiiensis* (68 FR 35950). The constituent elements essential for this species include, but are not limited to, steep or vertical cliffs or the base of cliffs or ridges in coastal dry cliff vegetation. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within coastal dry cliff vegetation. It is estimated that the entire critical habitat is within an area of vegetation that is predominantly non-native (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that this critical habitat unit is degraded due to non-native plant encroachment.

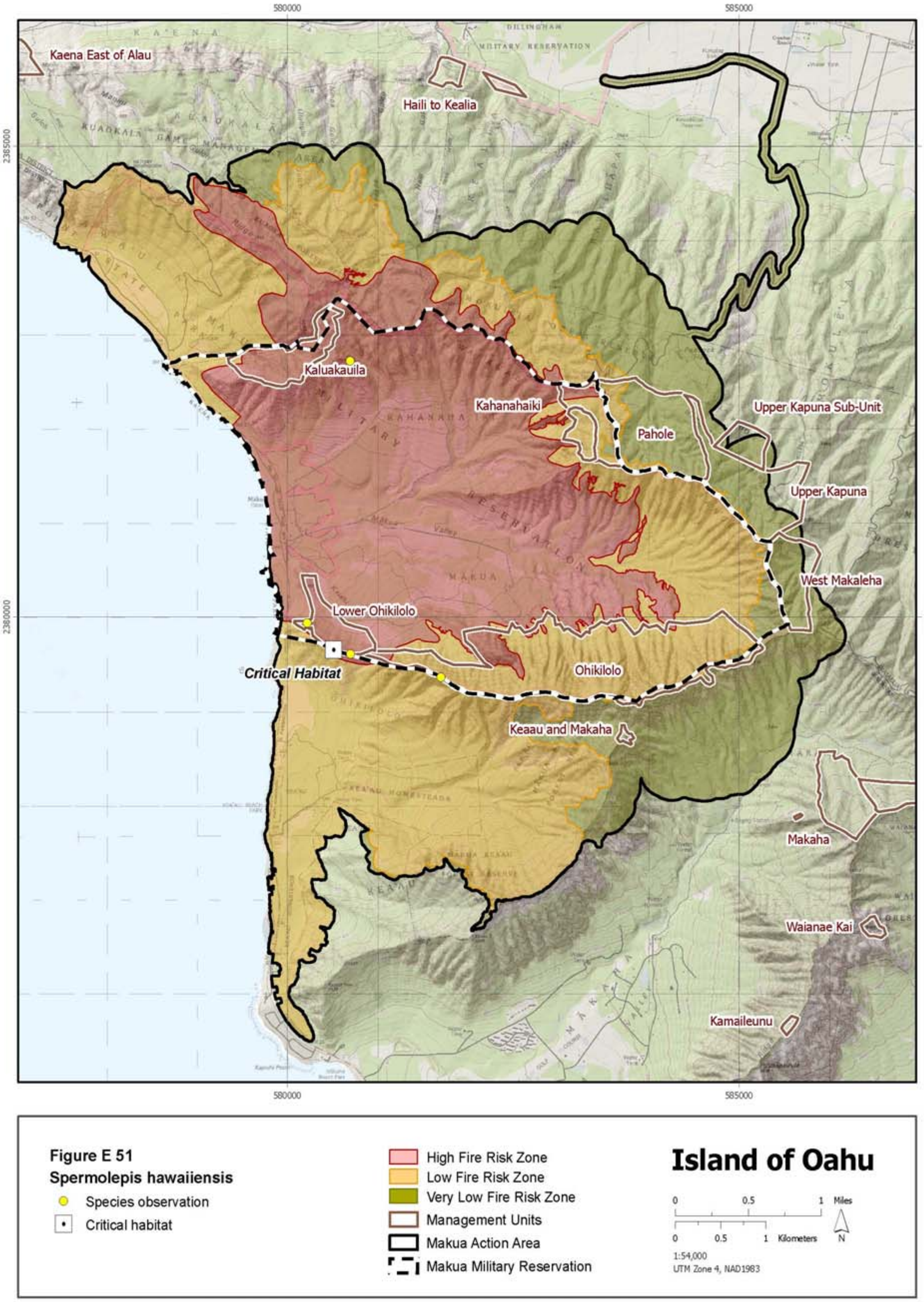
Should a fire from future training actions impact this critical habitat unit, the loss of the vegetative primary constituent elements and the subsequent invasion by aggressive non-native plant species will preclude natural recruitment. In the absence of habitat management, fires from future training actions could continue to degrade this critical habitat unit by removing the remaining vegetative primary constituent elements.

The critical habitat unit is approximately 0.3 km (0.2 mi) from the fire source and approximately four percent (0.04 ha; 0.1 ac) of the unit is in the Lower Ohikilolo Management Unit. Due to the proximity of this unit to the fire source, there is a risk that a fire could move south and impact it. The risk of fire in this predominantly non-native habitat is high. The surrounding vegetation is dominated by flammable non-native species such as *Leucana leucocephala* (koa haole) and *Panicum maximum* (guinea grass). The consequences of future fire events in this area are the continued encroachment of non-native grasses and increased risk of future fires reaching the critical habitat. The loss of vegetative primary constituent elements within this unit would remove its ability to provide for a portion of the habitat necessary for the conservation of one population of *Spermolepis hawaiiensis*. Presently fuel modification is being conducted along the ridgeline between the management unit and the installation boundary to reduce the risk of fire in this area (K. Kawelo, pers. comm. 2004; 68 FR 35950). In the Lower Ohikilolo Management Unit, the Army is reducing non-native plants pursuant to the objectives in the Makua Implementation Plan. This action will decrease the risk of fire within the management unit by reducing the fuel load in the area. In addition, a fuel management plan will be prepared and implemented to address fuel modification along the northern portion of this unit. This will further reduce the risk of wildland fire from encroaching into the management unit. The remaining critical habitat (0.0 ha; 0.1 ac) outside the management unit is separated from the impact area by the management unit. The fuel modification activities, plus other conservation actions implemented by the Army for species stability, will further reduce the risk of fire to the portion of critical habitat outside the management unit.

To reduce the negative impacts to the critical habitat unit from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of this critical habitat unit during the revegetation process, the ability of this unit to provide a portion of the habitat essential for the conservation of one population of *Spermolepis hawaiiensis* will be retained in the long-term.

Conclusion

The critical habitat unit for *Spermolepis hawaiiensis* in the Makua action area is located in the high fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. In addition, fuel reduction within the management unit will further buffer the critical habitat unit from fire. The portion of critical habitat unit that is within Lower Ohikilolo Management Unit will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *S. hawaiiensis* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *S. hawaiiensis* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *S. hawaiiensis.*


580000
585000
2385000
2380000
Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Critical Habitat
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 51
Spermolepis hawaiiensis
Species observation
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION ON PLANT CRITICAL HABITAT

Portions of designated critical habitat units for 36 plant taxa occur in the Makua action area. Location within the action area by definition means critical habitat is at risk of training-related wildfire. However, this risk is reduced because there is no critical habitat in Makua military reservation proper. Army-controlled (owned or leased) lands were excluded from plant critical habitat designation because they are covered by Integrated Natural Resource Management Plans (U.S. Army 2002) that adequately address the management and conservation of the listed species within these lands. Seventeen of the 36 taxa have critical habitat units designated on other islands besides Oahu. Individual effects analyses for each plant taxon with designated critical habitat in the action area follow this summary of effects to critical habitat in general.

Bonamia menziesii
Cenchrus agrimonioides var. *agrimonioides*
Chamaesyce celastroides var. *kaenana*
Chamaesyce herbstii
Colubrina oppositifolia
Cyanea grimesiana ssp. *Obatae*
Cyanea longiflora
Cyanea superba ssp. *Superba*
Cyrtandra dentate
Delissea subcordata
Diellia falcate
Dubautia herbstobatae
Euphorbia haeleeleana
Flueggea neowawraea
Gouania vitifolia
Hedyotis degeneri var. *degeneri*
Hedyotis parvula
Hesperomannia arbuscula
Hibiscus brackenridgei ssp. *mokuleianus*
Isodendrion laurifolium
Isodendrion longifolium
Isodendrion pyrifolium
Mariscus pennatiformis
Melanthera tenuifolia
Melicope pallida
Neraudia angulata
Nototrichium humile
Phyllostegia kaalaensis
Plantago princeps var. *princeps*
Sanicula mariversa
Schiedea hookeri
Schiedea kaalae
Schiedea nuttallii
Schiedea obovata
Solanum sandwicense
Spermolepis hawaiiensis

<u>Status Summary of Critical Habitat</u>

The best available scientific and commercial information is insufficient to determine the condition of plant critical habitat in the action area or throughout Oahu, or to predict quantifiable changes in the baseline conditions over the next 30 years, with or without the proposed action. In general, most native Hawaiian ecosystems are threatened by the same suite of factors related to the introduction and spread of non-native invasive species, and degradation and loss of native habitats. Nonetheless, the critical habitat units for these 36 plant taxa have a high existing background conservation value because they are generally designated on open, forested, or otherwise undeveloped lands that are important for the long-term recovery of listed plants. Recovery is dependent upon protection of existing population sites and suitable unoccupied habitat within the known historical range of these 36 taxa. Sites of these critical habitat units within the action area have high existing conservation value based on the quality, quantity, or availability of primary constituent elements. These primary constituent elements include topographic substrates (cliffs, gulches, rock walls, slopes, etc.) at specific elevations, native vegetation types (e.g., *Acacia koa-Metrosideros polymorpha* lowland mesic forest), and associated native plant species. The plant communities, associated species, and elevations are indicative of important physical and biological features such as soil moisture, nutrient cycling and availability, and microclimate (temperature ranges and light levels) that provide the primary constituent elements of the habitat required for these species' conservation. The primary constituent elements also support the ability of action area critical habitat to provide a portion of the habitat essential for the conservation of one or more populations of listed plants.

The action area encompasses less than 10 percent of the entire designated critical habitat for each of 18 of the 36 plant taxa, and only one percent or less for nine of them. The action area encompasses more than half of the entire designated critical habitat for only two taxa, *Schiedea obovata* (71 percent of entire designated critical habitat within the action area) and *Cyrtandra dentata* (68 percent). Some areas of critical habitat for both of these taxa are located in the high fire risk zone.

<u>Analyses for Effects of the Action</u>

The proposed action is likely to adversely affect portions of designated critical habitat units for 36 plant taxa within the action area, primarily through exposure to the risk of training-related wildfire and the ongoing impacts of non-native species. Effects of human disturbance (such as trampling along trails) are considered minor. The primary constituent elements of critical habitat are vulnerable to high and low severity fires throughout the year, depending on plant phenology and the time of year the fire occurs. Units of critical habitat are located in various fire risk zones within the action area (see Table E 15). Overall, 20 plant taxa have critical habitat areas within the high fire risk zone, including eight at-risk taxa, seven stabilization taxa, and five non-stabilization taxa.

All vegetation cover types within critical habitat units in the action area will be exposed to training-related wildfire and the ongoing impacts of non-native species (see Figures PD 1 and PD 2). These cover types include native, non-native, and mixed vegetation types ranging from grasslands, shrublands, and forest in dry and mesic habitats. All plants at all life stages are vulnerable to high and low severity fires throughout the year, depending on phenology and the time of year fire occurs. As discussed in the "General Effects of Fire on Native Hawaiian Plants" section, non-native grasses in Hawaii are adapted to rapidly regenerating on recently burned or otherwise disturbed sites. Training-related wildfire will further degrade critical habitat units by removing native vegetation, facilitating conversion to alien grasses, and precluding natural regeneration and habitat restoration by native species. Thus, fire effects within the action area will contribute to a loss of habitat function and reduce the conservation role of action area critical habitat units to the entire designated critical habitats for these taxa range-wide.

Primary constituent elements of critical habitat will be exposed to the direct and indirect effects of training-related wildfire over the next 30 years, due to their occurrence within the action area (see Table E 16 below). All plants and life stages, and their substrates and microclimate conditions, are vulnerable to high and low severity fires throughout the year, depending on phenology and the time of year fire occurs. For example, 20 plant taxa have some critical habitat areas within the high fire risk zone, including the at-risk taxa *Chamaesyce herbstii*, *Cyanea* *grimesiana* ssp. *obatae*, *Cyanea superba* ssp. *superba*, *Delissea subcordata*, *Gouania vitifolia*, *Hibiscus brackenridgei* ssp. *mokuleianus*, *Schiedea nuttallii*, and *Schieda obovata*. Vegetation in all high-risk areas is likely to burn under certain conditions. Even full staffing of on-site and standby fire suppression helicopter forces will not guarantee containment of all fires. On zero to 3.8 percent of historical potential training days analyzed, helicopter containment would have failed to contain a fire burning outside the firebreak road, if the fire had not been successfully contained before 1 pm. A fire escaping initial attack is likely to burn into the native forest (see Figure E 7 in General Effects), before additional helicopter support could arrive on-site. In addition, plants in the Kaluakauila, Kahanahaiki (C-Ridge vicinity), and Lower Ohikilolo management units are particularly vulnerable to training-related wildfire because they are located within dry, grassy areas that have burned in the past.

Plants growing in critical habitat areas outside the high fire risk zone are at a low to very low risk of burning from training-related wildfire. Twenty-four plant taxa have critical habitat areas in the low fire risk zone. These plants are likely to burn in fires that spread from fires that ignite in the high zone but close to the high fire risk boundary, from misfired or malfunctioning long-range weapons systems and munitions (tracers, AT-4 and SMAW anti-tank weapons, 2.75-caliber rockets, Javelin anti-tank missiles, and TOW missiles). Under certain adverse conditions (such as an unreported fire during an extreme drought), fires that start in or spread into the low fire risk zone could burn to the boundary of the very low fire risk zone.

Plants growing outside the low fire risk zone are at a very low risk of burning as a result of training-related wildfire ignited by a misfired or malfunctioning Javelin or TOW projectile under certain dry, windy weather conditions on steep slopes. Thirty of the 36 plant taxa with critical habitat have critical habitat areas located in the very low fire risk zone. These critical habitat units can burn from a “spot” fire, depending on topography, vegetation cover, weather, and suppression capability. The expected fire size from a misfired long-range Javelin or TOW projectile landing within intact shrub and/or forest vegetation is about 0.1 ha (0.3 ac), with immediate fire suppression response. If the fire is not noticed for 48 hours, it could spread over a maximum 40 ha (100 ac) before containment.

The areas exposed to training-related wildfire and invasive species in the action area include mixed native and non-native vegetation in mesic forest, dry forest, and dry grassland/shrubland habitats. Critical habitat units of several plant taxa are in or adjacent to areas at high risk of training-related wildfire within dry, grassy habitats of the Kaluakauila, Lower Ohikilolo, and Kahanahaiki (C-Ridge vicinity) management units. Critical habitat units within mesic, forested habitats in the Kahanahaiki, Pahole, Upper Kapuna, and West Makaleha management units are generally at lower risks of fire, except in areas of alien grass encroachment. Critical habitat units in the Ohikilolo Management Unit along the south valley rim and in the Keaau area beyond Ohikilolo Ridge are likewise at lesser risks of fire. Mesic conditions in upper-slope forests do not preclude the incidence of fire, however, especially during prolonged drought conditions in disturbed areas with grassy understories. The spread of wildfire from the C-Ridge area into the Kahanahaiki Management Unit, for example, is strongly influenced by grass. The 1995 and 2003 escaped prescribed burns increased the exposure of listed plants and primary constituent elements of critical habitat near this area to future fires by destroying native vegetation and increasing the alien grass cover. Much of the total critical habitat acreage in the action area is located within fenced management units, but not all of them are regularly controlled for invasive weeds. Mesic forest vegetation in weed control areas is probably fairly well protected from the spread of catastrophic fire. Vegetation in locations lacking weed control are not well protected from long-term fire encroachment into native and mixed forest. In general, critical habitat units are at less risk of fire if they are separated from the Makua training impact area by management units that are protected from fire by firebreaks or fuels modification, or by management units that contain greater cover of native forest.

To reduce the risk of training-related wildfire to critical habitat, the Army will use certain types of weapons systems and munitions for training at Makua only after completion of specific measures to protect at-risk taxa and expedite their stabilization (see General Effects - Expedited Stabilization and Table PD 2). In addition, as part of the proposed action, the Army will implement conservation and stewardship programs to reduce the risk of ignition and spread of training-related wildfire (Wildland Fire Management Plan, Installation Natural Resource Management Plan), augment numbers of at-risk taxa in the wild (Makua Final Implementation Plan Addendum), improve native habitat in population units by excluding feral ungulates and controlling non-native weeds (Makua Final Implementation Plan Addendum), and restore any critical habitat that burns to pre-burn conditions (Installation Natural Resource Management Plan).

The risk of fire to critical habitat will be minimized by training restrictions, fire management, and expedited stabilization actions summarized in Table PD 2 (see Project Description). Fire minimization measures are based on required levels of helicopter staffing to contain fires before they escape the firebreak road. In addition, to reduce the fire risk to critical habitat for certain taxa adjacent to the Lower Ohikilolo Management Unit (such as *Gouania vitifolia*, *Hibiscus brackenridgei* ssp. *mokuleianus*, and *Spermolepis hawaiiensis*), the Army will not begin any live-fire or blank-fire training until alien grass cover is removed and controlled within 3 m (9.8 ft) of listed plants and to less than 20 percent cover within 20 m (65.6 ft) of all native plants. Additional fuels modification within a 60-m (197-ft) swath along the inside perimeter of the south firebreak road will allow the Army to somewhat reduce the level of on-site helicopter staffing required. The risk of fire to portions of critical habitat units adjacent to the Kahanahaiki Management Unit will be reduced by fuels modification zones between the impact area and the Kaluakauila, Kahanahaiki, and Lower Ohikilolo management units. Within 5 to 10 years, plants growing within the Kahanahaiki and Kaluakauila management units will be protected by fuels breaks and perimeter firebreaks; these protections will provide a buffer between fire-risk zones and some critical habitat units. With these fuel modifications in place, the Army may train using small arms, demolitions, grenades, mines, simulators, and mortars and artillery, with the use of certain of these weapons systems and munitions restricted to National Fire Danger Rating System Green conditions. With completion of expedited stabilization of the at-risk taxa *Cyanea superba* ssp. s*uperba*, *Schiedea nuttalli*, and *Schiedea obovata*, the Army may begin training with more weapons systems and munitions under Yellow conditions instead of only under green conditions; and begin using grenade launchers and AT-4 and SMAW weapons under green or yellowconditions, depending on live herbaceous fuel moisture. Expedited stabilization of all 12 at-risk taxa must be complete before the Army may begin training with tracer ammunition, Javelins, and 2.75-caliber rockets. Full stabilization of all 16 stabilization taxa and all 12 at-risk taxa must be complete before the Army may begin training with TOWs. All these training restrictions and conservation measures will also benefit primary constituent elements of critical habitat where they co-occur.

Critical habitat within the management units will be managed to improve baseline quality. Without this management, some critical habitat units would eventually lose most of their constituent elements essential to the conservation of the species, in large part because of ongoing habitat threats associated with non-native invasive species. We considered this continued degradation of critical habitat in the evaluation of the affect of the proposed action. Most importantly, even though there may be a temporal loss of vegetation from fire, the Army's restoration of burned critical habitat areas will maintain or improve baseline conditions by replanting native plants (primary constituent elements) and by the control of non-native, competitive plant species. While there may be a temporary loss of the function of these critical habitat units after a fire and during the revegetation process, the ability of affected critical habitat units to provide a large portion of habitat essential for the conservation of 36 plant taxa will be retained in the long term. Overall, the Army's conservation and stewardship programs will benefit habitat essential for the conservation of 36 plant taxa in designated critical habitat units and contribute to the long-term recovery goals of these species.

<u>Response of Critical Habitat the Proposed Action</u>

The primary constituent elements of critical habitat in the action area are expected to experience changes in quality, quantity, or availability in response to the effects of the proposed action. Constituent elements include physical substrates (cliffs, gulches, etc., at specified elevations) and biological features (native plant associated species) in the action area that are expected to experience changes in quality (erosion, microclimate, species composition), quantity (relative proportion of native and non-native vegetation types), or availability (resulting from conversion to alien grassland) in response to the effects of the proposed action. The response of primary constituent elements to training-related wildfire and invasive species will include the direct and indirect effects of altered regeneration sites and microclimate conditions, plant injury and death by fire, ungulate grazing and trampling, invertebrate herbivory, and alien plant competition (see General Effects). As a result, the primary constituent elements of critical habitat in the action area are expected to decline in quality, quantity, or availability over the next 30 years. However, those changes in the conservation value of critical habitat would not be sufficient to appreciably reduce the conservation value of the entire, range-wide designated critical habitat for these 36 plant taxa. This conclusion implicitly recognizes the importance of spatial constituent elements such as total area in critical habitat units, spatial pattern and connectivity, and occurrence of contiguous areas large enough to potentially support populations of at least 300 individuals of a listed plant taxon.

The Service anticipates that implementation of fire management and species stabilization actions over the next 30 years will minimize training-related declines in quality, quantity, or availability of primary constituent elements of critical habitat of 36 plant taxa. The quality, quantity, and availability of primary constituent elements are expected to remain the same or improve within the action area, especially where they occur in management units for stabilization and at-risk species. The Army also will restore any critical habitat that burns as a result of training-related wildfire to pre-burn conditions. Any losses to primary constituent elements that occur as a result of fire protection and habitat management will be temporary and will not result in permanent destruction or alteration of the physical and biological features of critical habitat. In addition, significant progress is expected over the next 30 years toward full threat control in the management units. For example, the exclusion and removal of ungulates from the Pahole, Upper Kapuna, and West Makaleha management units, and the control of non-native invasive plants to reduce fuel loads in the Kaluakauila, Kahanahaiki, and Lower Ohikilolo management units, will enhance the conservation value of critical habitat units that are within or adjacent to these management units. Spatial separation from the military training impact area and conservation measures implemented by the Army for species stabilization in the management units will further reduce the risk of fire for much of the critical habitat in the action area. The Army and the Service will closely monitor the condition of critical habitat and revise management actions as necessary to maintain its conservation value to listed plants. Overall, the response of constituent elements to project subsidies is expected to result in retention or improvement of their quality, quantity, and availability over the next 30 years by minimizing adverse impacts of training-related wildfire and non-native species. Any changes in the conservation value of constituent elements are not expected to be sufficient to appreciably reduce the conservation value of the entire, range-wide designated critical habitat.

CONCLUSION

Based on the analysis above, the Service anticipates that stressors associated with training-related wildfire, and the introduction and spread of invasive species, are likely to result in adverse changes to critical habitat of 36 plant taxa by reducing by reducing the quality, quantity, or availability of primary constituent elements in the action area. Primary constituent elements will be exposed to high, moderate, and low risks of burning as a result of training-related wildfire over the next 30 years. The response of primary constituent elements to training-related wildfire will range from the direct effects of plant injury and death to the indirect effects of physiological stress, delayed mortality, habitat degradation, and competition with non-native species. The overall effect of training-related wildfire and spread of invasive species will be a further decline in conservation value of critical habitat to the 36 plant taxa within the action area. Critical habitat areas in the action area range from a minimum of less than 1 percent to a maximum of 71 percent of the entire designated critical habitats for these 36 plant taxa range-wide. Thus, reduced functionality of critical habitat in action area population units will significantly affect the range-wide status of these 36 plant taxa.

We develop our opinion using the best available scientific and commercial information, giving benefit of the doubt to the species if significant information gaps preclude determination of quantifiable effects. For example, the proposed action's training-related wildfire risk to critical habitat could be estimated more accurately with additional modeling to predict long-term fire frequency and encroachment in native and non-native vegetation types. Lacking that information, we infer from our knowledge and experience of the effects of fire and non-native species in native Hawaiian habitats (see General Effects) that any additional threats are likely to reduce the quality, quantity, or availability of primary constituent elements of critical habitat units in the action area. Our reasoning is based on information about the proposed action and the environmental baselines of primary constituent elements of critical habitat for 36 plant taxa in the action area. In addition, we make general inferences from this set of circumstances according to conservation biology principles regarding habitat disturbance and from previous experience regarding threats to the conservation of native vegetation in Hawaii (see General Effects section). Accordingly, we consider Army conservation and stewardship programs, including the Wildland Fire Management Plan, indispensable to maintaining the conservation value of designated critical habitat for 36 plant taxa.

Our conclusion is based on our best professional judgment of the likely response of the primary constituent elements of critical habitat for 36 plant taxa to both stressors and subsidies of the proposed action. Military training restrictions and conservation management for stabilization of 28 listed plant taxa will benefit critical habitat units where they co-occur with these actions. We anticipate that Army ecosystem-level protection within management units will benefit critical habitat in the action area over the next 30 years. The Army's multiple actions to minimize and reduce the risk of fire, minimize introduction and spread of non-native species, restore any critical habitat that is burned as a result of training-related wildfire, and maintain or improve the current baseline for primary constituent elements of critical habitat in the action area. Critical habitat would remain functional, or retain the current ability for the primary constituent elements to be functionally established, to serve the intended conservation role for the 36 listed plant taxa. Therefore, after reviewing the current status of the critical habitat for 36 plant taxa, the environmental baseline for critical habitat of these taxa in the action area, and the effects of the proposed action and the cumulative effects, it is the Service's biological opinion that the proposed action is not likely to destroy or adversely modify designated critical habitat by appreciably reducing its value for the conservation of the following 36 listed plant taxa: *Bonamia menziesii*, *Cenchrus agrimonioides* var. *agrimonioides*, *Chamaesyce celastroides* var. *kaenana*, *Chamaesyce herbstii*, *Colubrina oppositifolia*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea longiflora*, *Cyanea superba* ssp. *superba*, *Cyrtandra dentata*, *Delissea subcordata*, *Diellia falcata*, *Dubautia herbstobatae*, *Euphorbia haeleeleana*, *Flueggea neowawraea*, *Gouania vitifolia*, *Hedyotis degeneri* var. *degeneri*, *Hedyotis parvula*, *Hesperomannia arbuscula*, *Hibiscus brackenridgei* ssp. *mokuleianus*, *Isodendrion laurifolium*, *Isodendrion longifolium*, *Isodendrion pyrifolium*, *Mariscus pennatiformis*, *Melanthera tenuifolia*, *Melicope pallida*, *Neraudia angulata*, *Nototrichium humile*, *Phyllostegia kaalaensis*, *Plantago princeps* var. *princeps*, *Sanicula mariversa*, *Schiedea hookeri*, *Schiedea kaalae*, *Schiedea nuttallii*, *Schiedea obovata*, *Solanum sandwicense*, and *Spermolepis hawaiiensis*.

Table E 15. Environmental Baseline of Critical Habitat in the Action Area.

Species	Critical Habitat in Action Area hectares (acres)	Percent of Total Critical Habitat in Action Area	Fire Risk†
Bonamia menziesii	27.9 (69.0)	2	H, L
Cenchrus agrimonioides var. *agrimonioides*	188.8 (466.6)	15	H, L, V
Chamaesyce celastroides var. *kaenana*	29.7 (73.4)	6	H, L
Chamaesyce herbstii	204.6 (505.5)	41	H, L, V
Colubrina oppositifolia	20.7 (51.3)	<1	V
Cyanea grimesiana ssp. *obatae*	208.5 (512.2)	25	H, L, V
Cyanea longiflora	177.0 (437.4)	24	L, V
Cyanea superba ssp. *superba*	206.6 (510.5)	23	H, L, V
Cyrtandra dentata	207.9 (513.7)	68	H, L, V
Delissea subcordata	186.8 (461.6)	12	H, L, V
Diellia falcata	13.7 (33.8)	2	V
Dubautia herbstobatae	14.4 (35.5)	16	L, V
Euphorbia haeleeleana	4.3 (10.5)	1	H, L, V
Flueggea neowawraea	174.4 (430.8)	6	H, L, V
Gouania vitifolia	84.2 (208.0)	3	H, L, V
Hedyotis degeneri var. *degeneri*	212.1 (524.0)	23	H
Hedyotis parvula	6.7 (16.5)	1	V
Hesperomannia arbuscula	213.4 (527.3)	12	H, L, V
Hibiscus brackenridgei ssp. *mokuleianus*	0.0 (0.1)	<1	H
Isodendrion laurifolium	62.0 (153.3)	4	V
Isodendrion longifolium	0.5 (1.1)	<1	V
Isodendrion pyrifolium	1.3 (3.3)	<1	H, L
Mariscus pennatiformis	144.8 (357.8)	11	L, V
Melanthera tenuifolia	67.4 (166.5)	32	L, V
Melicope pallida	28.1 (69.3)	2	V
Neraudia angulata	6.1 (15.0)	1	V
Nototrichium humile	6.4 (15.9)	1	H, V
Phyllostegia kaalaensis	106.5 (263.1)	13	L, V
Plantago princeps var. *princeps*	61.8 (152.7)	2	L, V
Sanicula mariversa	10.0 (24.8)	11	L, V
Schiedea hookeri	30.3 (74.8)	3	H V
Schiedea kaalae	150.5 (371.9)	14	L, V
Schiedea nuttallii	199.7 (493.5)	16	H, L, V
Schiedea obovata	164.5 (406.4)	71	H, L, V
Solanum sandwicense	104.5 (258.2)	4	L, V
Spermolepis hawaiiensis	0.7 (1.7)	<1	H
Chasiempis sandwichensis ibidis	1106.3 (2733.7)	4	H, L, V

†Fire Risk: H (high), L (low), V (very low)

Table E 16. Fire Risk Exposure for Critical Habitat in the Action Area.

	Fire Risk		
	High	Low	Very Low
Bonamia menziesii	8.1 (20.1)†	19.8 (48.9)	--
Cenchrus agrimonioides var. *agrimonioides*	0.0 (0.1)	14.8 (36.7)	174.0 (429.9)
Chamaesyce celastroides var. *kaenana*	4.1 (10.1)	25.6 (63.3)	--
Chamaesyce herbstii	0.0 (0.1)	19.7 (48.8)	184.8 (456.6)
Colubrina oppositifolia	--	--	20.8 (51.3)
Cyanea grimesiana ssp. *obatae*	0.1 (0.3)	15.7 (38.7)	192.7 (476.2)
Cyanea longiflora	--	9.2 (22.6)	167.9 (414.8)
Cyanea superba ssp. *superba*	0.2 (0.5)	17.1 (42.3)	189.3 (467.7)
Cyrtandra dentata	0.2 (0.6)	17.6 (43.6)	189.9 (469.2)
Delissea subcordata	0.2 (0.6)	13.0 (32.2)	173.5 (428.7)
Diellia falcata	--	--	13.7 (33.8)
Dubautia herbstobatae	--	1.7 (4.2)	12.7 (31.4)
Euphorbia haeleeleana	4.3 (10.6)	--	--
Flueggea neowawraea	0.2 (0.6)	16.8 (41.6)	157.2 (388.5)
Gouania vitifolia	1.7 (4.2)	82.3 (203.3)	0.2 (0.5)
Hedyotis degeneri var. *degeneri*	0.2 (0.6)	16.7 (41.3)	195.0 (481.8)
Hedyotis parvula	--	--	6.7 (16.5)
Hesperomannia arbuscula	0.2 (0.6)	17.8 (44.0)	195.2 (482.3)
Hibiscus brackenridgei ssp. *mokuleianus*	0.0 (0.1)	--	--
Isodendrion laurifolium	--	--	62.0 (153.3)
Isodendrion longifolium	--	--	0.4 (1.1)
Isodendrion pyrifolium	0.8 (2.1)	0.5 (1.2)	--
Mariscus pennatiformis	--	13.4 (33.1)	131.3 (324.4)
Melanthera tenuifolia	--	7.7 (19.0)	59.6 (147.4)
Melicope pallida	--	--	28.1 (69.3)
Neraudia angulata	0.0 (0.0)	--	6.1 (15.0)
Nototrichium humile	5.1 (12.6)	--	1.3 (3.3)
Phyllostegia kaalaensis	--	8.1 (19.9)	98.4 (243.1)
Plantago princeps var. *princeps*	--	3.4 (8.3)	58.3 (144.2)
Sanicula mariversa	--	0.3 (0.8)	9.7 (24.0)
Schiedea hookeri	5.8 (14.2)	0.0 (0.0)	24.5 (60.6)
Schiedea kaalae	0.0 (0.0)	7.4 (18.2)	143.1 (353.6)
Schiedea nuttallii	0.2 (0.6)	17.1 (42.3)	182.2 (450.2)
Schiedea obovata	0.0 (0.1)	14.5 (35.9)	149.9 (370.4)
Solanum sandwicense	--	5.3 (13.2)	99.1 (245.0)
Spermolepis hawaiiensis	0.7 (1.7)	0.0 (0.1)	--
Chasiempis sandwichensis ibidis	178.3 (440.6)	388.4 (959.8)	539.6 (1333.3)

0.0 = trace (<0.1)

† = hectares (acres)

-- = no critical habitat present within exposure zone

EFFECTS OF THE ACTION ON PLANT SPECIES WITH ONLY CRITICAL HABITAT IN THE ACTION AREA

EFFECTS OF THE ACTION – *Colubrina oppositifolia* Critical Habitat

Approximately 21 ha (51 ac), or less than one percent of the total designated critical habitat for *Colubrina oppositifolia,* is located in the Makua action area (Figure E 52). The critical habitat is in the northeastern portion of the action area and outside of the high risk fire area within only the very low fire zone 20.75 ha (51.27 ac). The critical habitat unit is part of a larger 782 ha (1,935 ac), unit that extends outside of the action area and was designated to provide habitat for the conservation of three populations of *C. oppositifolia*. Each population will include at least 100 mature, reproducing individuals in order to meet the recovery goals for this species (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, lowland dry or mesic forests dominated by *Diospyros sandwicensis* (68 FR 35950). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within dry or mesic forests dominated by *D. sandwicensis*. It is estimated that 74 percent of the critical habitat is located in an area of no more than 50 percent native plant cover, indicating that the unit is somewhat degraded due to non-native plant encroachment (K. Kawelo, pers. comm. 2004; 68 FR 35950). Although somewhat degraded, the critical habitat unit still supports individuals of *C. oppositifolia* and provides habitat that is necessary for the expansion of this population. An increase of non-native vegetation creates a denser fuel load, thus increasing the risk of fire in this critical habitat unit. Resource management is necessary to reverse the trend of habitat degradation.

There is a very minimal risk that a fire could travel from the impact area or ignite outside of the impact area and burn into this unit. This is due to the beneficial actions conducted by the Army in the management units, the low flammability of the surrounding vegetation (mesic forest), and the spatial separation of the critical habitat from the impact area. Seventy-seven percent of the critical habitat unit is in management units (Upper Kapuna, Upper Kapuna Sub-Unit, West Makaleha management units). This critical habitat unit is located along the northern edge of the Upper Kapuna and West Makaleha management units, creating even a larger native forest buffer against a training-related fire (see Figure E 52).

The Army has fenced portions of the West Makaleha Management Unit and, in addition to fencing the remainder of this management unit, plans to fence the Upper Kapuna and Central and East Makaleha management units, pursuant to the Makua Implementation Plan. Ungulates will be removed from these fenced areas. The removal of ungulates and non-native plants from within management units enhances the conservation value of the critical habitat. The remaining critical habitat (5 ha; 12 ac) outside of the management units is separated from the impact area by the management units. The fuel modification activities plus other conservation measures implemented by the Army for species stabilization within the management units provides an additional buffer that will further reduce the risk of fire to the portion of the critical habitat outside of the management units.

Conclusion

The critical habitat unit for *Colubrina oppositifolia* in the Makua action area is located in the low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the beneficial resource management actions conducted by the Army in the management units such as fencing, removal of ungulates and non-native plants, the low flammability of the surrounding mesic forest vegetation, and the spatial separation between the impact area and the critical habitat unit. Without the fuel modification activities and other conservation measures, this critical habitat unit could eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *C. oppositifolia* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *C. oppositifolia* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *C. oppositifolia.*

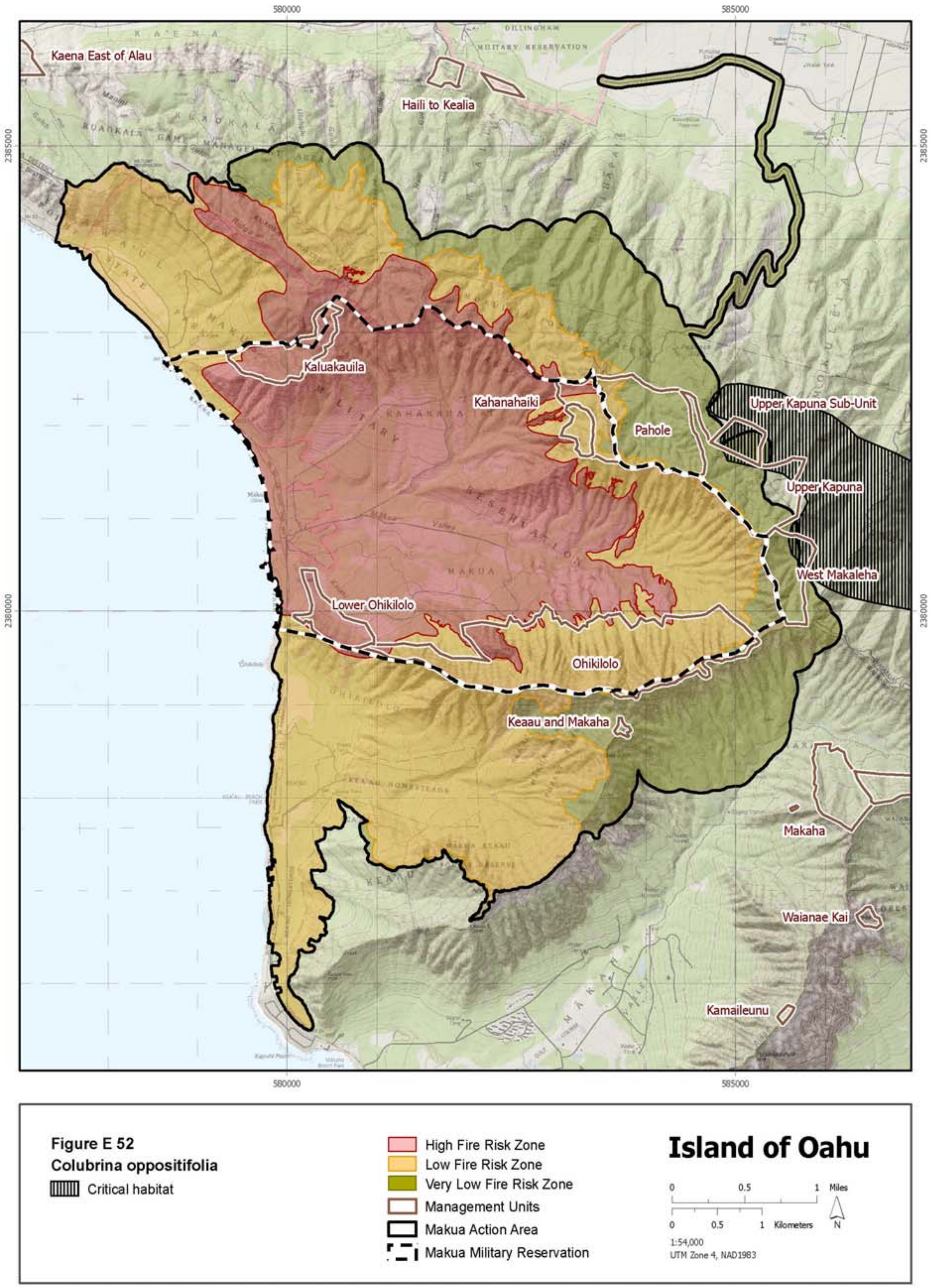


Figure E 52
Colubrina oppositifolia

Effects of the Action on *Isodendrion laurifolium* Critical Habitat

The critical habitat for *Isodendrion laurifolium* in the Makua action area represents approximately four percent (62 ha; 153 ac) of the total critical habitat designated for this species (Figure E 53). The unit, located in the northeastern portion of the action area, is in the very low fire risk zone. This portion of the critical habitat, together with 554 ha (1,371 ac) outside the Makua action area, was designated to provide habitat for the conservation of four populations, each with at least 300 reproducing individuals of *I. laurifolium* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, gulch slopes, ravines, or ridges in diverse mesic or dry forest dominated by *Metrosideros polymorpha* (ohia), *Acacia koa* (koa), *Eugenia reinwardtiana* (nioi), or *Diospyros sandwicensis* (lama). The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within diverse mesic or dry forest. It is estimated that more than one-half of the critical habitat is in an area with 50 to 75 percent native plant cover (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that there is some encroachment of non-native plants in this critical habitat unit, and without management, the habitat could continue to degrade with removal of remaining vegetative primary constituent elements.

There is a risk that if a fire could move east and impact this unit. Seventy-one percent of the critical habitat unit is in management units (Upper Kapuna, Upper Kapuna Sub-Unit, West Makaleha). The Army has fenced portions of the West Makaleha Management Unit and plans to fence the remainder of this management unit, as well as the Upper Kapuna, and Central and East Makaleha management units, pursuant to the Makua Implementation Plan. Ungulates will be removed from all fenced areas. The Army is reducing non-native plants in all of these management units. In addition, the Army is conducting rat control in the West Makaleha Management Unit to reduce their impacts on listed and associated native plants. All of these threat abatement actions in the management units enhance the conservation value of the critical habitat. The remaining critical habitat (43 ha; 105 ac) outside of the management units is separated from the impact area by the management units themselves. The fuel modification activities plus other conservation measures implemented by the Army for species stabilization will further reduce the risk of fire to this critical habitat.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and by the control of non-native, competitive plant species. While there may be a temporal loss of the conservation value of this critical habitat unit during the revegetation process, the ability of this unit to provide habitat essential for the conservation of *Isodendrion laurifolium* will be retained in the long term.

<u>Conclusion</u>

The critical habitat unit for *Isodendrion laurifolium* in the Makua action area is located in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to fuel reduction within the management units that buffer the critical habitat unit from fire. The portion of the critical habitat unit that is within the Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered the continued degradation of *I. laurifolium* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of this area by the Army will provide habitat essential for the conservation of *I. laurifolium* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *I. laurifolium*.

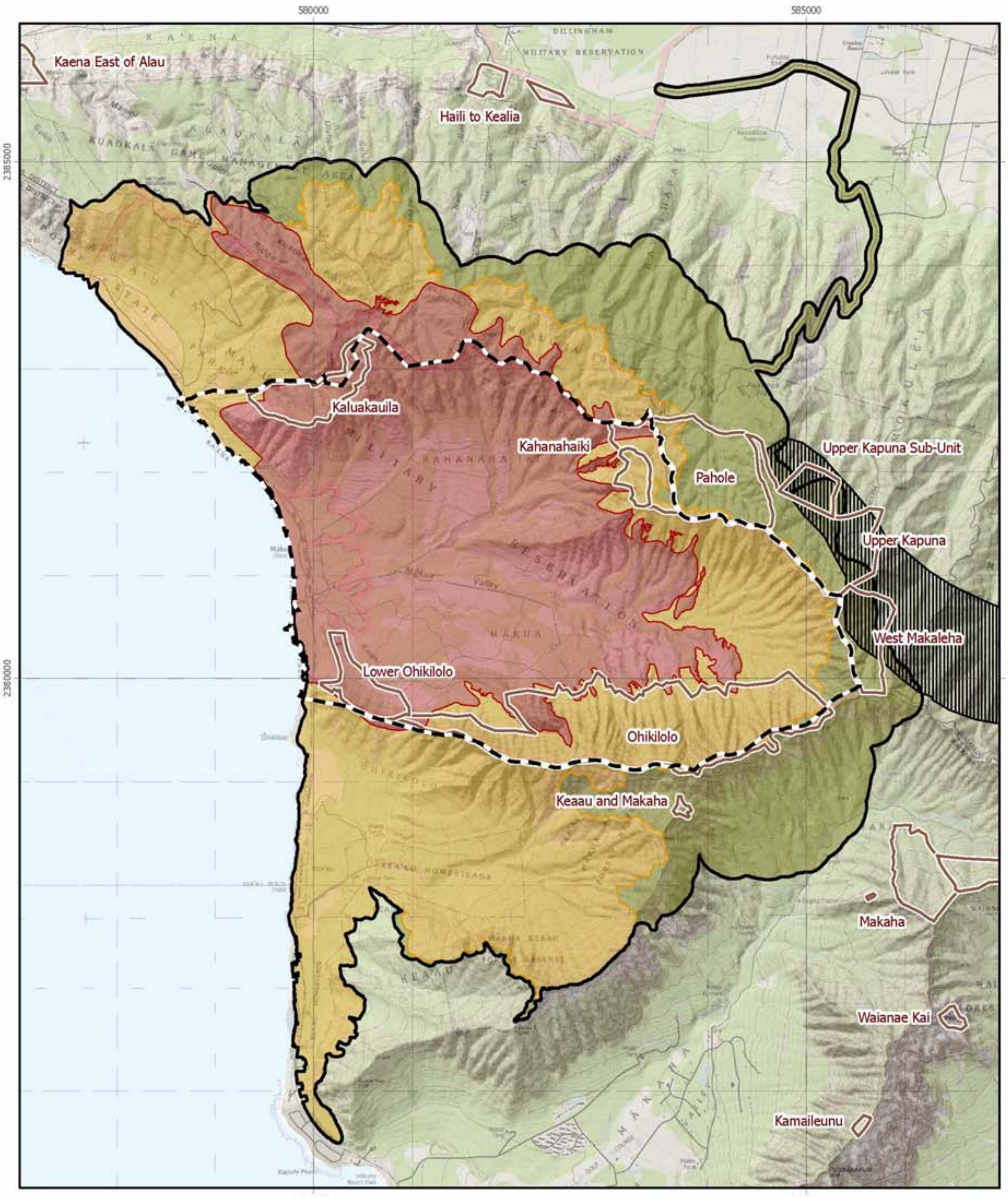


Figure E 53
Isodendrion laurifolium
Critical habitat

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Isodendrion longifolium* Critical Habitat

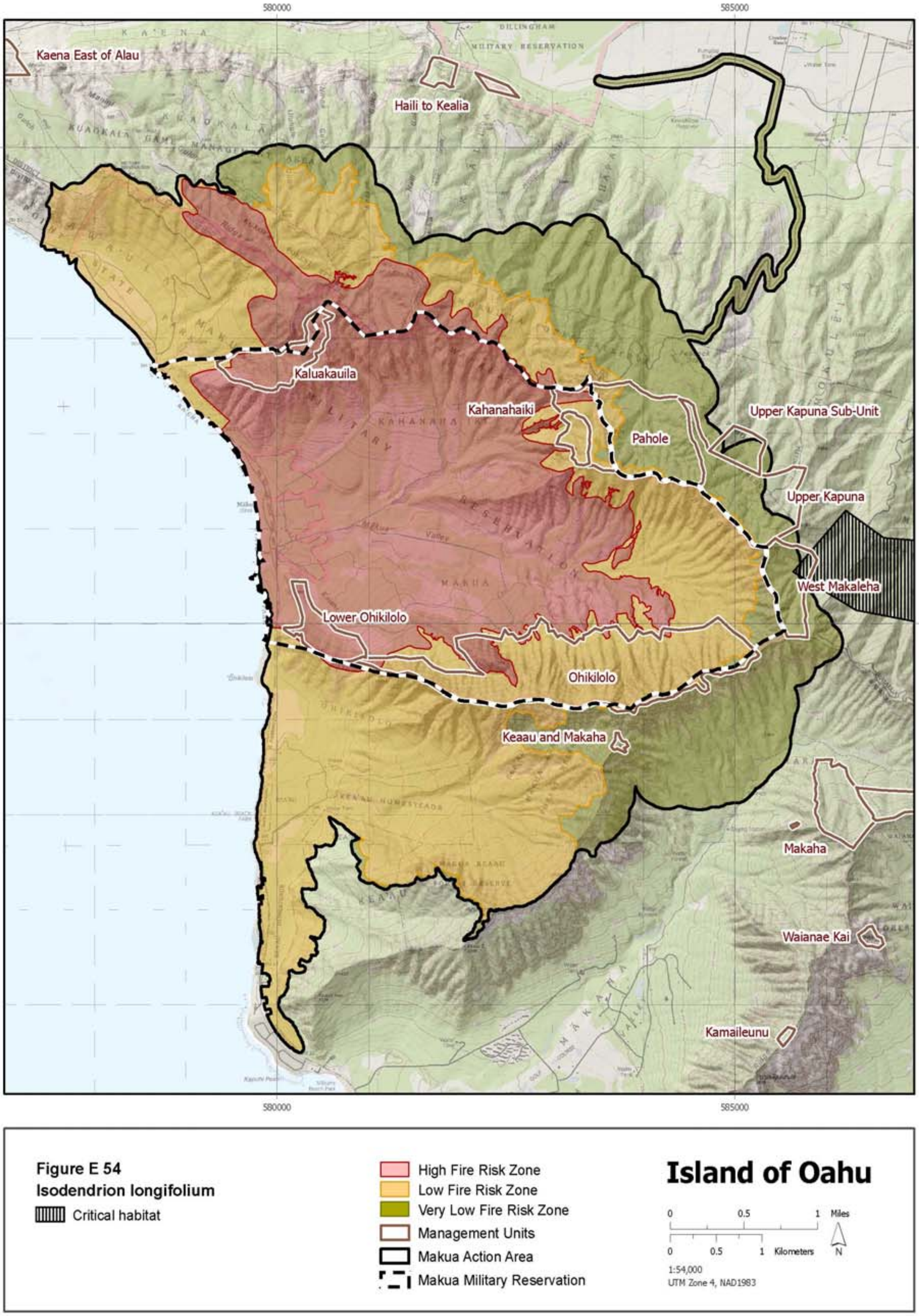
Critical habitat for *Isodendrion longifolium* in the Makua action area is comprised of close to zero percent (0.5 ha; 1 ac) of the total critical habitat for this species (Figure E 54). The unit is located in very low fire risk area with 0.45 ha (1.12 ac).The critical habitat in the action area, together with 551 ha (1,362 ac) outside the action area, was designated to provide habitat for the conservation of three populations of *I. longifolium*. Each population will include at least 300 mature, reproducing individuals in order to reach recovery goals for this species (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, steep slopes or stream banks in mixed mesic or lowland wet *Metrosideros polymorpha* (ohia)-*Dicranopteris linearis* (uluhe) forest. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a mixed mesic or lowland wet forest. It is estimated that more than 90 percent of the critical habitat is in an area with less than 50 percent native plant cover (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that this critical habitat unit is very degraded by non-native plant encroachment and other impacts such as foraging by ungulates. In the absence of habitat management, ongoing degradation and fires from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

There is a risk that if a fire started in the impact area, it could move east and impact this unit or that a misfired round could ignite outside of the firebreak road and burn into this unit. The loss of primary constituent elements within this critical habitat unit would preclude the conservation of *Isodendrion longifolium*. However, this risk is reduced due to the beneficial resource management actions conducted by the Army in the management units, the low flammability of the surrounding vegetation (mesic or wet forest), and spatial separation (3 km; 2 mi) from the impact area. One hundred percent, 0.5 ha (1 ac), of the critical habitat is located within the West Makaleha Management Unit. To reduce the risk of fire to listed species and sensitive habitats, the Army will reduce fuels in the West Makaleha unit. It will do this through the removal of non-native plant species, some of which are highly flammable. The Army has fenced portions of the West Makaleha Management Unit, pursuant to the Makua Implementation Plan. Ungulates will be removed from all fenced areas. All of these threat abatement actions in the management units enhance the conservation value of the critical habitat. In addition, the Army is conducting rat control in the West Makaleha Management Unit to reduce their impacts on listed and associated native plants.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and by controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of this critical habitat unit during the revegetation process, the ability of this unit to provide habitat essential for the conservation of *Isodendrion longifolium* will be retained in the long-term.

Conclusion

The critical habitat unit for *Isodendrion longifolium* in the Makua action area is located in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to fuel reduction within the management units, and this action will further buffer the critical habitat unit from fire. The portion of the critical habitat unit that is within West Makaleha Management Unit will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered the continued degradation of *I. longifolium* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of this area by the Army will provide habitat essential for the conservation of *I. longifolium* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *I. longifolium*.



580000
585000
2385000
2380000
Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
Figure E 54
Isodendrion longifolium
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – *Isodendrion pyrifolium* Critical Habitat

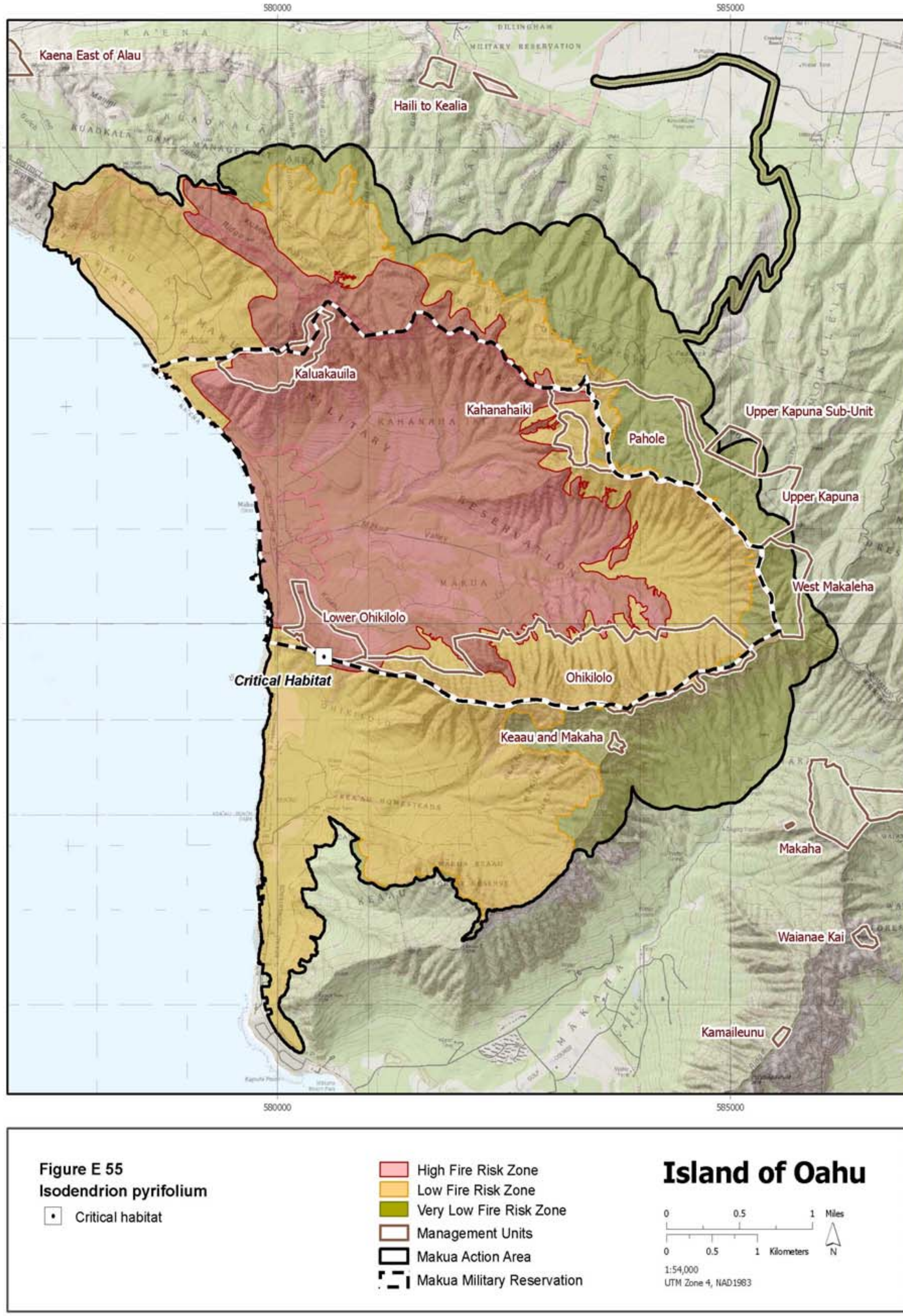
There is one critical habitat unit within the Makua action area, comprising less than one percent, or one hectare (3 ac), of the total critical habitat for *Isodendrion pyrifolium*. The unit is located in the southwestern portion of the action area, in two fire risk zones with 0.48 ha (1.19 ac) in the low and only 0.84 hectares (2.07 ac) in the high fire risk area (Figure E 55). This unit is currently unoccupied and provides a portion of the critical habitat necessary for the establishment of one population of at least 300 mature *I. pyrifolium* in order to meet the recovery goals for this species (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, bare rocky hills or wooded ravines in dry shrublands. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within a dry shrubland community. The critical habitat unit is in an area that is dominated by non-native plant species, indicating that it is degraded due to non-native plant encroachment (K. Kawelo pers. comm. 2004; 68 FR 35950). Portions of this critical habitat may have been impacted by past fires that diminished the conservation value of the habitat by removing the vegetative primary constituent elements. Subsequent invasion of burned areas by aggressive non-native plants precludes natural recruitment. In the absence of habitat management, fires from future training actions could add to the degradation of this critical habitat unit by removing the remaining vegetative primary constituent elements.

The critical habitat unit is approximately 0.4 km (0.2 mi) from the fire source and there is a high risk that a fire started in the impact area could move south and impact this unit. The risk is increased due to the surrounding vegetation that is dominated by *Panicum maximum* (see Figure PD 2), which is highly flammable and can increase the frequency and size of wildland fires (Beavers et al 1999). The prescribed burn in 2003 encroached within 0.4 km (0.2 mi) of this critical habitat unit. The consequence of this fire event is the encroachment of non-native grasses that provide more flammable fuel and increase the potential for fires in the future. The loss of vegetative primary constituent elements within this critical habitat unit would remove its ability to provide a portion of habitat necessary for the conservation of one population of *Isodendrion pyrifolium*. However, the majority of the critical habitat is outside of Lower Ohikilolo Management Unit and will benefit from the management actions that occur within the adjacent management unit. The Army has prepared a fire management plan for the Lower Ohikilolo Management Unit. Implementation of this plan will reduce the risk of fire due to the construction of a fuel modification zone between the impact area and the management unit. Fuel modification will buffer the Lower Ohikilolo Management Unit from fires that spread outside the impact area and reduce the probability that the critical habitat unit will burn. In addition, the Army has fenced the Lower Ohikilolo Management Unit and is working to reduce non-native plants within the exclosure. The removal of ungulates (goats) and non-native invasive plant species from within this management unit enhances the conservation value of the critical habitat unit. The fuel modification activities, plus other conservation measures implemented by the Army for species stabilization, will further reduce the risk of fire to this critical habitat unit.

To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of this critical habitat unit during the revegetation process, the ability of this unit to provide habitat essential for the conservation of one population of *Isodendrion pyrifolium* will be retained in the long-term.

Conclusion

Less than one percent (1 ha; 3 ac) of the total State-wide critical habitat for *Isodendrion pyrifolium* is located in one unit in the high fire risk area of the Makua training action area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to construction of a fuel modification zone between the impact area and Lower Ohikilolo Management Unit. In addition, fuel reduction within the management unit will further buffer the critical habitat unit from fire. The portion of critical habitat that is within the Lower Ohikilolo Management Unit will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered the continued degradation of *I. pyrifolium* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of this area by the Army will provide habitat essential for the conservation of *I. pyrifolium* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *I. pyrifolium*.


Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Critical Habitat
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
580000
585000
2385000
2380000
Figure E 55
Isodendrion pyrifolium
Critical habitat
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
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UTM Zone 4, NAD1983

Effects of the Action on *Mariscus pennatiformis* Critical Habitat

The critical habitat unit within the Makua action area represents 11 percent (145 ha; 358 ac) of the total critical habitat designated for *Mariscus pennatiformis* (Figure E 56). The unit is located in the northeastern portion of Makua and is almost entirely within the two low fire risk zones, with 13.40 ha (33.12 ac) in the low fire risk area and only 131.26 hectares (324.36 ac) in the very low fire risk area. The unit was designated to provide habitat for the conservation of two populations, each with at least 300 mature, reproducing individuals of *M. pennatiformis* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, mesic and wet *Metrosideros polymorpha* (ohia) forest and ohia-*Acacia koa* (koa) forest. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within mesic and wet ohia forest and ohia-koa forest. It is estimated that close to 90 percent of the critical habitat is located in areas that have greater than 50 percent native plant cover (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that this critical habitat unit still supports a relatively healthy native forest although invasive plant encroachment has occurred. Hawaiian forests will continue to decline in health and native vegetation without resource management. Fires increase this rate of habitat degradation and vegetative primary constituent elements would be lost in a single burn with little or no natural regeneration. In the absence of fire, native habitat quality from invasive animals and plants continues to decline incrementally, eroding the health and vigor of the remaining vegetative primary constituent elements.

There is a risk that a fire ignited in the impact area could burn into this unit, or a misfired round could start a fire that could impact this unit. Ninety-six percent of the critical habitat unit is in management units including Kahanahaiki, Pahole, Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha management units. The remaining critical habitat (5 ha; 13 ac) outside of the management units is spatially separated from the impact area by areas of low and very low fire risk and several management units. The critical habitat unit for *Mariscus pennatiformis* is very similar to *Schiedea obovata* due to its location and the Army actions that will occur in and adjacent to this unit. Please see *Schieda obovata* for the detailed discussion regarding management units and reduced risk of fire in this area.

<u>Conclusion</u>

The critical habitat unit for *Mariscus pennatiformis* in the Makua action area is located almost entirely in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's Standard Operating Procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the construction of a fuel modification zone between the impact area and the Kahanahaiki Management Unit. In addition, fuel reduction within the management units will further buffer the critical habitat unit from fire. The portion of critical habitat that is within the Pahole, Upper Kapuna, and West Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *M. pennatiformis* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *M. pennatiformis* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *M. pennatiformis*.

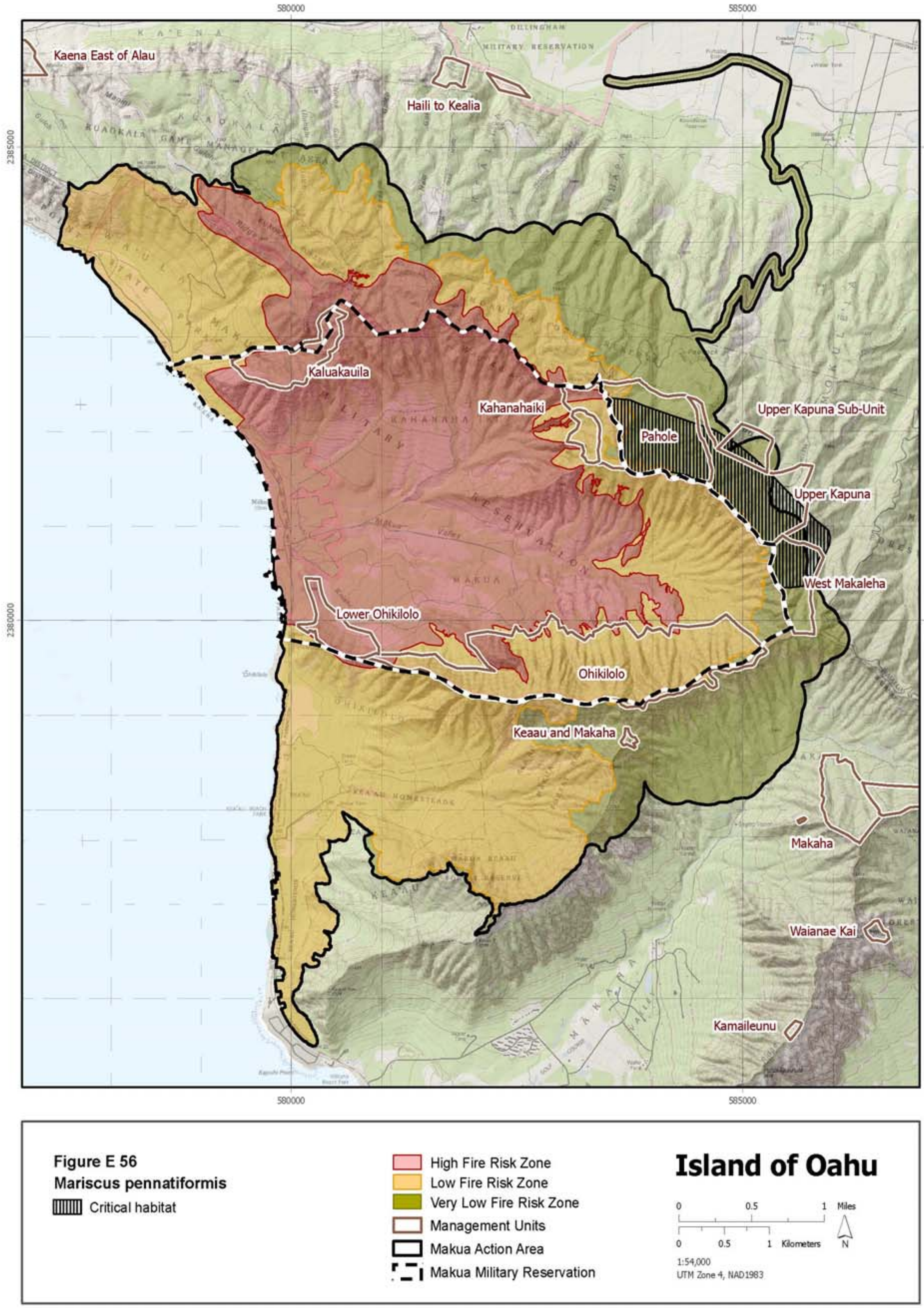


Figure E 56
Mariscus pennatiformis

EFFECTS OF THE ACTION – *Melicope pallida* Critical Habitat

There is one designated critical habitat unit within the Makua action area for *Melicope pallida* (Figure E 57). This unit represents approximately 2 percent (28 ha; 69 ac) of the total critical habitat for this species. The unit is located in the northeastern portion of the action area in the very low fire risk zone with 28.06 ha (69.34 ac) in the area (see Figure E 57). This portion of the critical within the action area, along with 826 ha (2,042 ac) outside of the action area, was designated to provide habitat for the conservation of three populations, each of at least 100 mature, reproducing individuals of *M. pallida* (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, steep rock faces in lowland dry or mesic forests. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found within lowland dry or mesic forests. It is estimated that 70 percent of the critical habitat is located in areas with less than 50 percent native plant cover (K. Kawelo pers. comm. 2004; 68 FR 35950). This indicates that this critical habitat unit is somewhat degraded by non-native plant encroachment. Non-natives increase the vegetative biomass, thus increasing the risk of fire. Habitat management is necessary to control these invasive plants, and, without this management, the habitat will continue to degrade.

There is a risk that a fire started in the impact area or a misfired round could ignite outside of the firebreak and burn into this unit. Sixty-eight percent of the critical habitat unit is in the Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha management units. Please see *Schiedea obovata* for more information on the management units and the resulting beneficial aspects of Army resource management actions in these units. The remaining critical habitat for *Melicope pallida* (9 ha; 22 ac) outside of the management units is spatially separated from the impact area by areas of low and very low fire risk and several management units. This critical habitat unit is located further to the north and therefore, a larger buffer exists between the impact area and the unit. A fire would have to travel a great distance through mesic forest to impact this critical habitat (see Figure E 57). The risk of fire is reduced due to the beneficial resource management actions conducted by the Army in the management units, low flammability of the surrounding vegetation (dry or mesic forests), and a large spatial separation from the impact area.

<u>Conclusion</u>

The critical habitat unit for *Melicope pallida* in the Makua action area is located entirely in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the fuel reduction within the management units. The portion of the critical habitat that is within the Upper Kapuna, Upper Kapuna Sub-Unit and West Makaleha management units will be managed to improve its baseline quality, pursuant to the Makua Implementation Plan. Without this management, this critical habitat would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *M. pallida* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *M. pallida* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *M. pallida*.

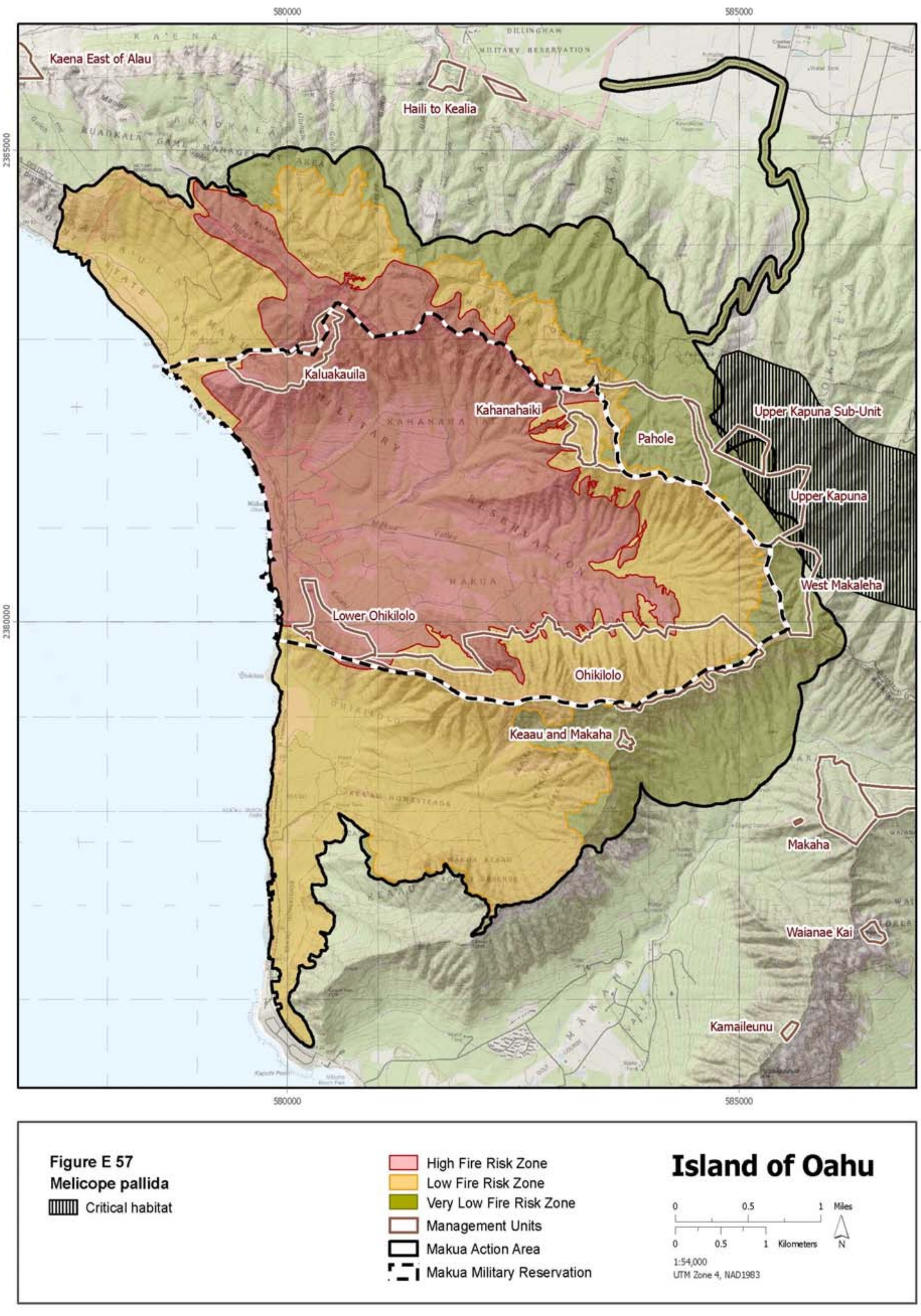


Figure E 57
Melicope pallida

EFFECTS OF THE ACTION – *Solanum sandwicense* Critical Habitat

There is one critical habitat unit within the Makua action area, representing four percent (105 ha; 258 ac) of the total critical habitat for *Solanum sandwicense* (Figure E 58). The unit is located in the northeastern portion of the action area in the two low fire risk zones, with 5.32 ha (13.15 ac) in the low fire risk area and 99.16 ha (245.03 ac) in the very low fire risk area (see Figure E 58). This portion of the critical habitat was designated to provide for the conservation of one population of *S. sandwicense* with at least 300 mature, reproducing individuals (68 FR 35950). The primary constituent elements essential for this species include, but are not limited to, talus slopes or streambeds in open, sunny areas. The primary constituent elements that may be affected by a training-related fire include those associated native plant species found on talus slopes or streambeds in open, sunny areas. It is estimated that nearly one-half of the critical habitat is located in an area of greater than 75 percent native plant cover, indicating that this unit still maintains a healthy native plant component (K. Kawelo pers. comm. 2004; 68 FR 35950). However, in the absence of habitat management, fires resulting from future training actions could degrade this unit by removing the remaining vegetative primary constituent elements.

There is a risk that a fire could move east and impact this unit. The loss of vegetative primary constituent elements within this critical habitat unit would remove its ability to provide for the conservation of one population of *Solanum sandwicense*. However, this risk is reduced due to the beneficial actions conducted by the Army in the adjacent management units, the low flammability of the surrounding vegetation, and spatial separation from the impact area. A total of 102 ha (253 ac), or 98 percent, of the critical habitat in the action area is in the Pahole, Upper Kapuna Sub-Unit and Upper Kapuna management units. The Kahanahaiki Management Unit is immediately adjacent to the western edge of the critical habitat unit. This management unit will serve as a buffer between the critical habitat and the impact area due to the fuel reduction actions in the management unit. The Pahole Management Unit is fenced and the Army plans to fence the Upper Kapuna Management Unit, pursuant to the Makua Implementation Plan. The Army is working to reduce non-native plants in both of these management units. These threat abatement actions in the management units enhance the conservation value of the critical habitat. The remaining critical habitat (3 ha; 5 ac) outside of the management units is separated from the impact area by the two management units themselves. The fuel modification activities, plus other threat reduction measures implemented by the Army for species stabilization, will further reduce the risk of fire to the portion of the critical habitat outside of the management units.
To reduce the negative impacts to critical habitat from any fire that escapes the firebreak road, the Army has committed to revegetate burned areas with native plant species to restore the area to pre-burn conditions. The revegetation plan will address restoration of burned areas by replanting native plant species (primary constituent elements) and controlling non-native, competitive plant species. While there may be a temporal loss of the conservation value of this critical habitat unit during the revegetation process, the ability of this unit to provide habitat essential for the conservation of three populations of *Solanum sandwicense* will be retained in the long-term.

<u>Conclusion</u>

The critical habitat unit for *Solanum sandwicense* in the Makua action area is located in the low and very low fire risk area. Implementation of all fire suppression measures incorporated into this action and the Army's standard operating procedures will reduce the likelihood that a fire will ignite and travel outside of the firebreak road or that a misfired round will ignite outside of the firebreak road. The risk of fire will be reduced due to the fuel reduction actions within the Pahole, Upper Kapuna Sub-Unit and Upper Kapuna management units. The portion of critical habitat that is within these management units will be managed to improve its baseline quality pursuant to the Makua Implementation Plan. Without this management, this critical habitat unit would eventually lose most of the elements essential to the survival and recovery of the species because of the ongoing threats to this habitat (e.g., ungulates and non-native plant encroachment). We considered this continued degradation of *S. sandwicense* critical habitat in the evaluation of the effects of the proposed action. Most importantly, even though there may be a temporal loss of vegetation due to a fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *S. sandwicense* and allow for the long-term recovery goals of this species. Therefore, training-related fire events will not result in adverse modification of critical habitat for *S. sandwicense*.

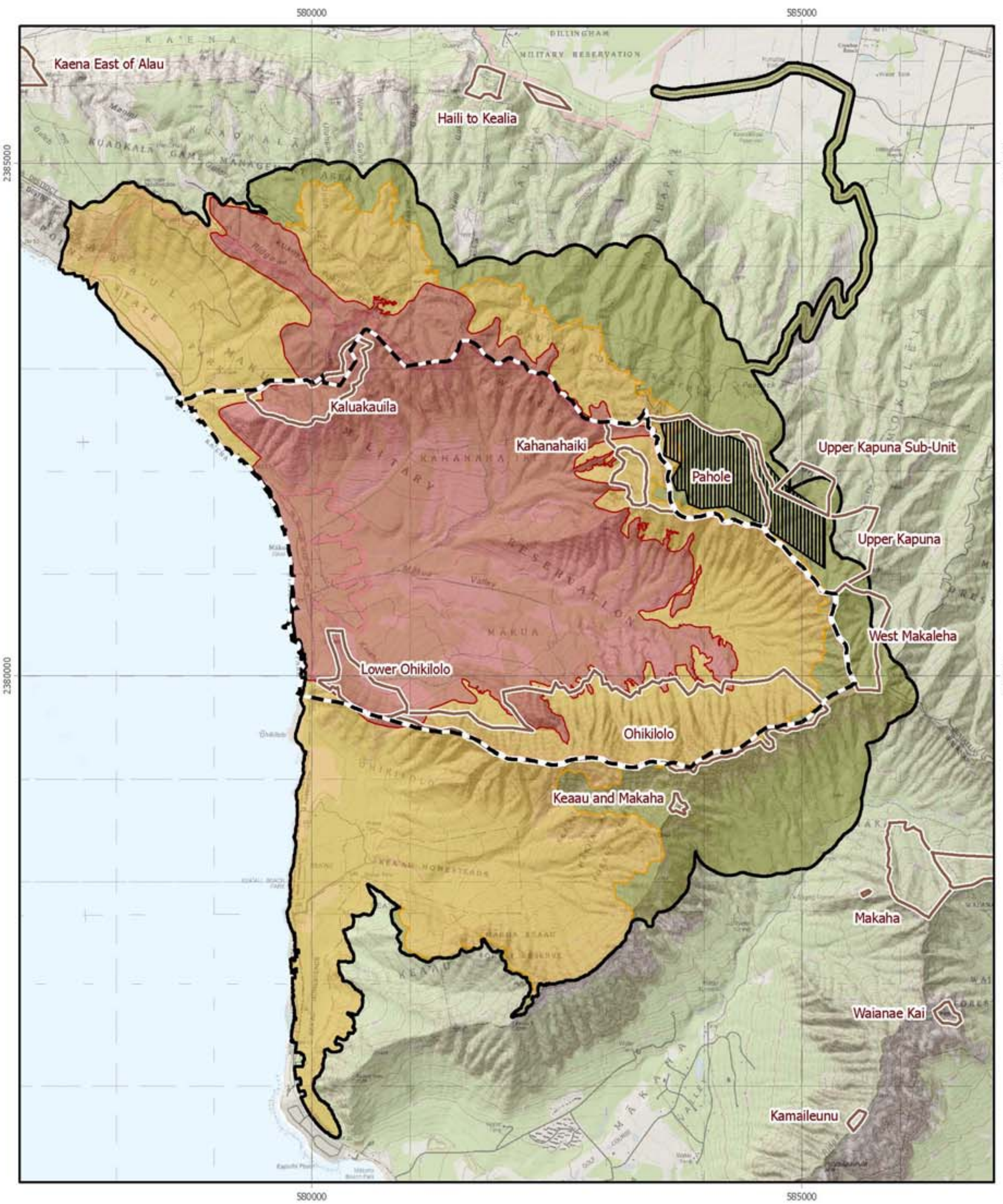


Figure E 58
Solanum sandwicense

Critical habitat

High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation

Island of Oahu

0 0.5 1 Miles
0 0.5 1 Kilometers
N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – Oahu Tree Snail

There are approximately 1,500 individuals of *Achtinella mustelina* known from approximately 94 known populations at 120 point occurrences in the Waianae Mountains. Seventeen of these populations are within the Makua action area (Figure E 59) and they support approximately 430 individuals (approximately 28 percent of the total known individuals). The locations are Kahanahaiki (4 populations, approximately 86 snails); Pahole Gulch (2 population, 2 snails), Kapuna-Makua Ridge (3 populations, approximately 16 snails), and South Makua Ridge (8 populations, approximately 358 snails). For a complete analysis of the effects, also see the General Effects section of this document.

Introduction of Alien Plant and Animal Species

Achtinella mustelina is highly vulnerable to the direct effects of alien predators, especially rats and the predatory snails *Euglandina rosea* (Hadfield and Mountain 1980, Hadfield 1986, Hadfield and Miller 1989, Kinzie 1992; Hadfield, Miller and Carwile 1993). Disposal of food in the field associated with military troop activities in areas where tree snails occur may attract rats by temporarily increasing the local food supply for rats, contributing to an increase in local rat populations. Observations of MRE (meals, ready-to-eat) containers and other trash and food items along trails that support tree snails indicate that this has been a problem in the past(S.E. Miller, in litt. 1988; M.G. Hadfield, pers. comm. 1988). However, the Army's Standard Operating Procedures require all food and trash to be carried out, And therefore, we don't anticipate any impacts.

Oahu tree snails are dependent on native vegetation and are not generally known to establish viable occurrences on non-native plant species (Service 1993). Non-native plants are spread via seeds on boots, equipment, or clothing, or in the feathers, fur, and feces of pigs, goats, and birds. These effects are especially intense along trails or in areas that may be used for camping or bivouacs. Within the Makua, some upper elevation areas used for troop movements (such as the old Nike Missile site and Pahole) are in areas known to support tree snails. The introduction of non-native plant species to habitats currently considered suitable for Oahu tree snails will limit the snail's ability to establish new occurrences and will eventually lead to an overall decline in tree snail abundance. The risk and potential effects of non-native plant introductions vary among different portions of the action area, depending on the degree of troop and vehicle activities. However, once introduced into an area, these invasive plants can spread along trails or throughout the forest understory. The threat of non-native plants spreading from military activities will be reduced by the Army's proposed conservation measures that include cleaning boots, clothing, equipment, and vehicles prior to entering areas that support native vegetation, and controlling non-native plants along trails. Thus the overall threat from these invasive plants to Oahu tree snails covered in this consultation is considered to be low.

Impacts from Dismounted Troop Movement

Impacts from dismounted troop movement along trails and through the forested areas within the Makua action area are a significant threat to Oahu tree snails. Troop movements along trails and through forested areas may result in trampling of tree snails and their host plants, or inadvertently knocking tree snails out of their host plants. Troop movements in areas that support Oahu tree snails are expected to be low because (1) troops are required to stay on established roads and trails; and (2) the Army will mark areas that support tree snails so that troop movement activities avoid the tree snails and their host plants. Based on these conservation actions, the overall threat from dismounted troop movements to Oahu tree snails covered in this consultation is considered to be low.

Restrictions on Access for Resource Management

Tree snail areas within the Makua action area require regular access for management due to the continuing threat of habitat degradation by feral pigs and non-native plants, and predation by rats and predatory snails. Currently, all of the known tree snail occurrences are outside of areas where access is limited due to training. Thus, the timing of training activities at Makua should have no effect on management of tree snails.

Fires from Military Training

The Oahu tree snail and its habitat in the action area will be exposed to direct and indirect effects of training-related wildland fire over the next 30 years, due to their occurrence within the low and very low fire risk zone of the Makua action area. One of the major effects of fire on Oahu tree snails, aside from burning and killing individual tree snails, is the loss of habitat needed to support the species. Fires facilitate the spread of non-native plants, which are not used as host plants by Oahu tree snails.

All Oahu tree snails and tree snail habitat within the Makua action area are at risk, albeit very low, of burning as a result of training-related wildland fire ignited by a misfired or malfunctioning Javelin or TOW, or a spot fire from an intense fire burning in Makua Valley under certain dry, windy weather conditions. Fire detecting and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hour period (see General Effects – Fire Suppression).

In addition, two of the Oahu tree snail populations at Kahanahaiki Management Unit are within 150 m (492 ft) of the high fire risk zone. These populations are at risk of burning in fires that spread from fires that ignite in the high fire risk zone, from misfired or malfunctioning long-range weapons systems and munitions (tracers, AT-4 and SMAW anti-tank weapons, 2.75-caliber rockets, Javelin anti-tank missiles, and TOW missiles). The low risk of fire to these populations is further reduced by the firebreak or fuelbreak the Army is creating along the perimeter of the Kahahaiki Management Use (see Project Description section 3.1.4.1).

The overall risk of fire to Oahu tree snails will be minimized by training restrictions, fire management, and expedited stabilization actions for 12 at-risk plant taxa. In addition, as part of the proposed action, the Army will implement conservation and stewardship programs to reduce the risk of ignition and spread of training-related wildland fire (Wildland Fire Management Plan, Integrated Natural Resources Management Plan), and improve native habitat in population units by excluding feral ungulates and controlling non-native weeds (Makua Implementation Plan Addendum).

Summary

The risk to Oahu tree snails from Army live-fire training has been reduced through the restrictions the Army has made to its routine training activities and the development and implementation of its fire suppression measures (see General Effects – Fire Supression). Despite the ongoing exposure of these snails to project impacts, Army conservation and stewardship programs will improve the baseline condition of *Achatinella mustelina* in the action area and throughout its range. Weapons restrictions, fuels management, fire suppression, invasive species control, and snail conservation actions over the next 30 years will all contribute to the improvement in the baseline of *A. mustelina*. The overall effect of the proposed action's stressors and subsidies will result in a net increase in baseline numbers, distribution, and reproduction of *A. mustelina* in and adjacent to the action area over the next 30 years, and so enhance the probability of persistence over the long term.

This tree snail species is not considered stable at this time, but the stabilization actions to be developed for the Makua Implementation Plan will benefit the species so that potential impacts associated with military training activities will be minimized in the short-term and the species will be stabilized in the long-term. When fully implemented, the Makua Implementation Plan should stabilize the Oahu tree snail and increase the environmental baseline of the species overall. Based on the actions and issues outlined in the Project Description and the Effects of the Action on the Listed Species sections above and the species stabilization actions as described in the Makua Implementation Plan, the Service believes that the risk of the Army's proposed action is outweighed by the long-term benefits from stabilizing this tree snail species.

Conclusion

After reviewing the current status, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is our Biological Opinion that implementation of the proposed action discussed herein is not likely to jeopardize the continued existence of any species covered in this Biological Opinion or adversely modify or destroy any critical habitat. This conclusion is based on the following factors for the Oahu tree snails.

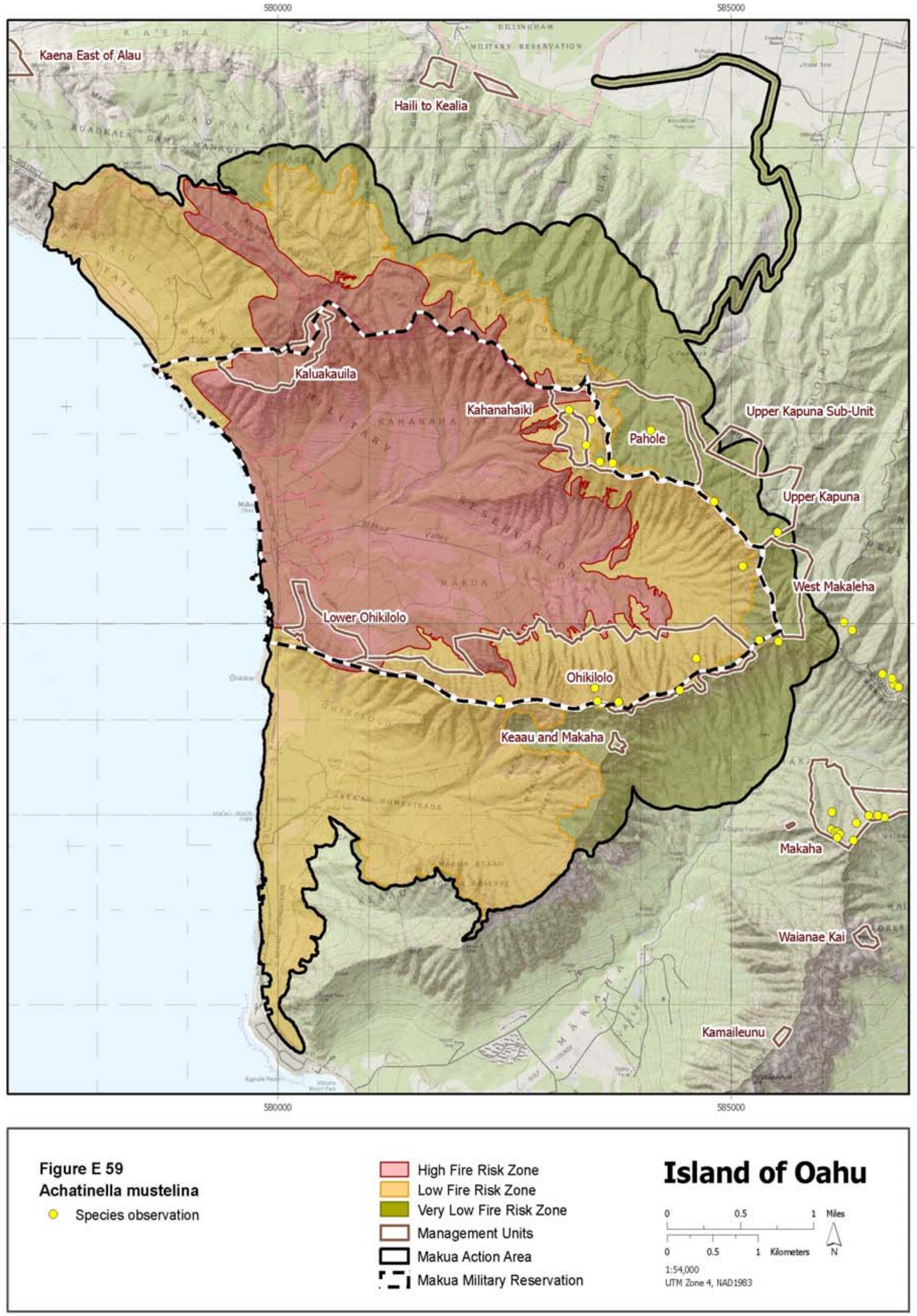
1. The Service's finding of no jeopardy in this Biological Opinion is based in large part on the conservation measures and stabilization plan that will be developed for Oahu tree snails by experts in natural resource management. Eight wild populations each containing 300 snails, will be stabilized. These units will be geographically distributed throughout the range of the species and will include as much of the genetic diversity of the species as remains in the wild.

2. Although some Oahu tree snails may be adversely affected by actions discussed in this consultation, the potential for direct injury or harassment of these tree snails has been minimized by incorporating a range of actions into the project design that will protect extant tree snail occurrences from Army training activities.

3. Captive propagation is recognized as a critical element in the process of stabilizing Oahu tree snails. The establishment of field populations that can sustain these species in the wild is the long-term goal of the conservation measures described in this Biological Opinion and in the implementation process. *Achatinella mustelina* are being successfully reared in captivity. Translocation from captive propagation to new field sites has been accomplished for closely related Hawaiian tree snail species. Captive propagation currently protects representatives of all eight evolutionarily significant units of *Achatinella mustelina*.

4. Implementation of the fire suppression measures and weapons restrictions will reduce the risk of fire escaping the impact area, which significantly reduces the potential impact of fire on *Actatinella mustelina* tree snail populations and habitat.

Army training actions described in the Biological Opinion are not anticipated to compromise the conservation and recovery process described in the Oahu Tree Snail Recovery Plan (Service 1993). This recovery plan is based on (1) the presence of a functionally intact native forest with a close or closed canopy and an understory of native plants that can support tree snail populations; (2) a tree snail population structure that includes all age classes and supports reproductive rates that are high enough to sustain the population; (3) a landscape distribution of populations that preserves the remaining genetic diversity of each of the tree snail species within its natural range; (4) ecological conditions that can support metapopulation dynamics where specific populations may decline or disappear over time while new populations within the landscape become established and grow; and (5) management of the threats that currently prevent the recovery of the species. Consequently, the Service has determined that adverse effects to Oahu tree snails that may result from Army training activities will not contribute to an appreciable reduction in the likelihood of survival or recovery of *Achatinella* tree snail species in the wild by reducing the number of snails or their reproduction or distribution.


Kaena East of Alau
Haili to Kealia
Kaluakauila
Kahanahaiki
Pahole
Upper Kapuna Sub-Unit
Upper Kapuna
West Makaleha
Lower Ohikilolo
Ohikilolo
Keaau and Makaha
Makaha
Waianae Kai
Kamaileunu
580000
585000
2385000
2380000
Figure E 59
Achatinella mustelina
Species observation
High Fire Risk Zone
Low Fire Risk Zone
Very Low Fire Risk Zone
Management Units
Makua Action Area
Makua Military Reservation
Island of Oahu
0 0.5 1 Miles
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N
1:54,000
UTM Zone 4, NAD1983

EFFECTS OF THE ACTION – Oahu elepaio

Of the 1,703 total range-wide individuals of *Chasiempis sandwichensis ibidis* **(**Oahu elepaio), 16 (less than one percent) are located within the Makua action area. Most Oahu elepaio occur within six populations in the Waianae and Koolau mountains (VanderWerf et al 2001). Most recent surveys indicate that Waianae Mountains populations have declined between 73 and 85 percent since 2001 (VanderWerf 2006 and Mosier pers. comm).

<u>Direct mortality</u>

Misfired or malfunctioning Javelin, TOW, and 2.75-caliber rockets, and ball ammunition rounds overshooting the target area may hit and kill Oahu elepaio within the action area (Figure E 60). Eight out of the 16 elepaio occupying territories in the action area occur within the surface danger zones of the proposed weapons, where direct mortality is possible. Oahu elepaio within 500 m (1,640 ft) of a Javelin detonation may be hit by warhead and missile debris. It is difficult to estimate the number of elepaio that could be hit by misfired and overshot ball ammunition, Javelin and TOW rounds, but it is extremely low.

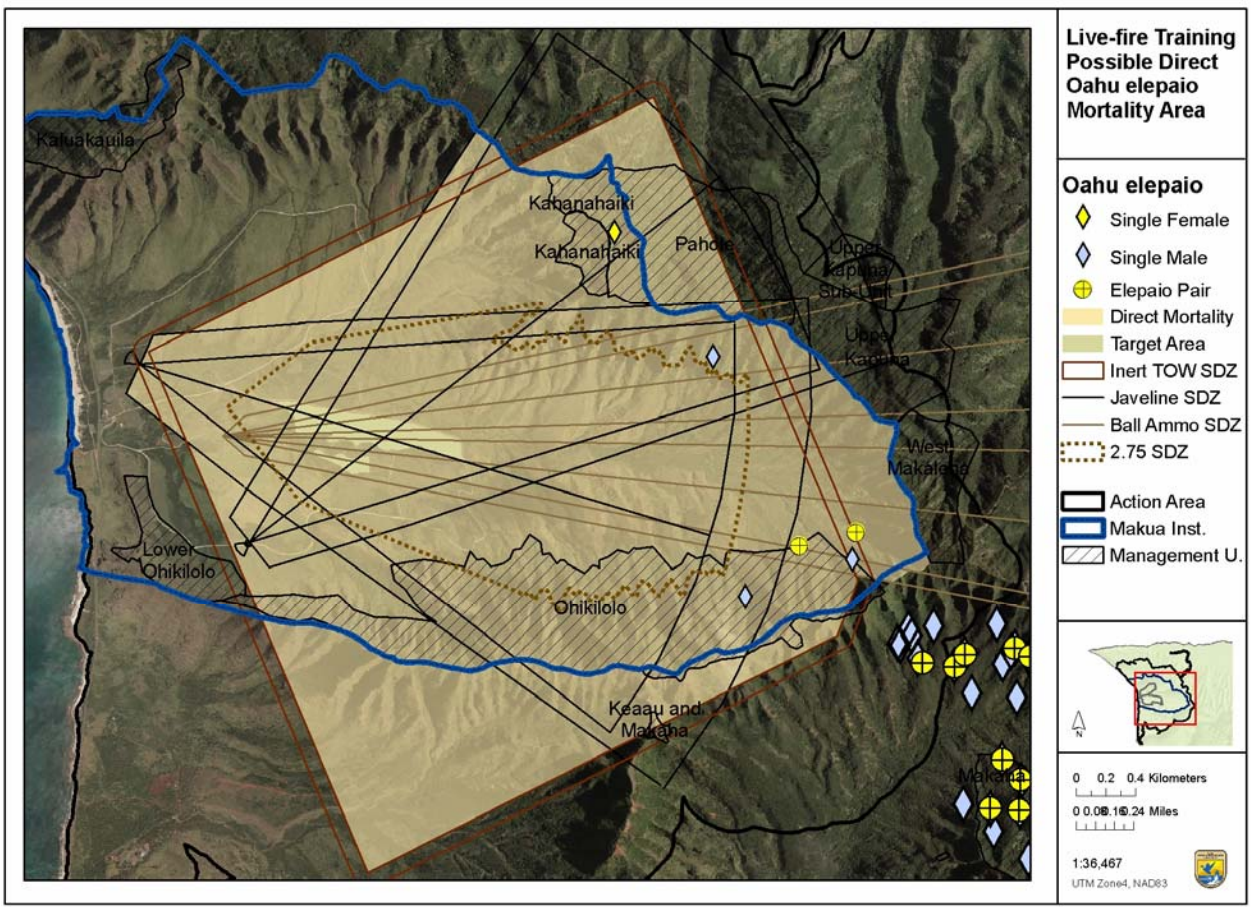

Figure E 60. Direct Oahu elepaio mortality due to weapon use is possible but unlikely inside the shaded area.

Fire Effects

Eight Oahu elepaio (two pairs, three single males, and one single female) occupy territories in the low fire risk zone at Makua (Figure E 61). These birds could be impacted by fires escaping initial attack containment in the high fire risk zone, a spot fire resulting from an intense grass fire in the valley during extreme weather conditions, or a fire resulting from misfired TOW, Javelin, and 2.75-caliber rockets. The other eight Oahu elepaio (one pair and six single males) maintain territories in the very low fire risk zone in Makaha Valley where a fire can start from a misfired long-range, live-fire weapons such as the TOW, or start from a spot fire.

Smoke and heat from wildland fire can cause direct mortality or reduced reproductive success of birds (Cahill and Walker 2000). Heat and smoke from a fire within or adjacent to an Oahua elepaio territory may kill the bird(s) within the territory. In addition, a fire that burns through the habitat will kill the plants and alter the habitat so that is no longer provides all of the functions (foraging, nesting, sheltering, dispersal) essential for the Oahu elepao. For example, the 2003 escaped prescribed fire burned portions of three elepaio territories that were occupied by single males. The habitat was altered and these burned areas no longer contain the elements needed by elepaio for foraging, nesting, sheltering or dispersal, and no longer support elepaio. In addition, a fire during the breeding season could result in the direct loss of a nest or abandonment of the nest if the adults die or have to leave the territory to escape the fire (Cahill and Walker 2000). In either case, the eggs and/or nestlings associated with the nest will be killed.

Firebreaks and fuelbreaks are designed to limit fire spread from the valley floor into elepaio habitat (see General Effects – Fire Suppression). In addition, fire detection and suppression response is designed to prevent a fire ignited by misfired weapons landing in forest and shrub areas from burning more than 0.1 ha (0.3 ac) (see General Effects - Fire Suppression). Inadequate detection and suppression response could enable these fires to burn more than 40 ha (100 ac) in a 48-hr period (see General Effects - Fire Suppression). However, to avoid the risk of an undetected fire, the Army will conduct an aerial survey in a helicopter for one hour post-training to check for smoke from a misfired round (see General Effects - Fire Suppression). In addition, post-fire restoration of burned Oahu elepaio critical habitat areas will minimize long-term impacts of live-fire training effects on this species.

Fire Retardant impacts to Oahu elepaio

During fire suppression operations, some helicopter fire suppression buckets may be filled with retardants in order to increase the effectiveness of the water being applied. Although the Oahu elepaio currently occupying the action area do not occur in areas where retardant is likely to be used, direct contact with chemical fire retardants may occur. Some fire retardants, including the Fire-Trol brand currently used by the Army, contain cyanide. Prolonged exposure to cyanide results in cancer and neurological disorders in humans but the effects of the chemicals on feathers or health of birds is not known. Direct contact with individual birds seems unlikely and prolonged exposure is not expected.

<u>Noise impacts to Oahu elepaio</u>

The proposed live-fire training and associated use of helicopters and other equipment will result in loud noise. Noise attenuation due to distance, terrain shielding, wind and noise attenuation will result in damping of the noise. Therefore, birds within Makua Valley will be exposed to louder sound than birds occurring outside the valley wall terrain barriers. Oahu elepaio occur approximately 1,700 m (5,577 ft) to 2,000 m (6,562 ft) from the target areas in Makua valley. Infrequently, helicopters performing fire suppression, natural resources, or training operations may fly within 15 m (50 ft) of elepaio, and personnel cadence, or Army Natural Resources Staff talking will occur within 15 m (50 ft) of birds.

Table E 17. Noise Levels of Live-Fire Training Compared With Familiar Noise Levels.

Noise Source	Decibel (dBA) at 15 m (50 ft) from source	Approximate Decibel (dBA) at 1,700 m upwind* from source	References
Rustling leaves, tall grass in a light to moderate wind, ambient elepaio habitat	35 to 55 dBA	0 dBA	Resource Systems Group, Inc. 2006, VanderWerf *et. al.* 2000
Normal conversation, Office, Restaurant	60 dBA	0 dBA	Wikipedia
Shouting	65 dBA	0 dBA	League for the Hard of Hearing 2007
Ambulance Siren	94 dBA	24 dBA	Department of Defense 2007
Helicopter	95 to 107 dBA	25 to 37 dBA	Santa Barbara County 2002, San Diego Gas and Electric 2006
Civil Defense Siren	124 dBA	53 dBA	Department of Defense 2007
Rifle, Handgun, Shotgun	139 to 146 dBA	69 to 75 dBA	League for the Hard of Hearing 2007
Artillery, 25 kg (55 lb) HE detonation	168 to 173 dBA	98 to 103 dBA	Global Security.org 2007, League for the Hard of Hearing 2007

* Bruer and Khaer (2007)

Potential consequences of live fire training, personnel hiking or working, and fire suppression operations could include increased metabolism, nest abandonment, and temporary damage to auditory cells. VanderWerf (2000) studied the responses of Oahu elepaio at the Schofield Barracks West Range to 282 artillery (60 mm HE, 105 mm HE, and 155 mm HE) and demolition blasts located 100 to 1,000 m (328 to 3,281 ft) from elepaio nests, ranging in intensity from 81.4 to 116 dB. Effects of artillery blast noise were only detected in two instances: in both instances, an incubating male elepaio was preening his breast feathers with its head down when a blast occurred and it suddenly looked up and scanned immediately after the blast, as if attempting to visually locate the source of the sound. The response was minor and short-lived in both cases; the male lowered its head and resumed preening 1 to 2 seconds after each blast noise had subsided. The sounds that elicited these responses were 89 to 90 dB, not among the loudest sounds recorded at the nest sites. In no case did an elepaio flush from the nest or pause when returning to the nest in response to an artillery noise. This study suggests that Oahu elepaio reproductive success is not negatively impacted by noise associated with live-fire training.
The elepaio studied at Schofield Barracks West Range may be habituated to the noise associated with live-fire training and since training has not been conducted at Makua for several years, it may take some time for the birds at Makua to habituate to the noise. Birds habituate to noises and may not respond to stimuli when they do not perceive a direct threat. American black ducks (*Anas rubripes*) reacted to 39 percent of military aircraft overflights on their first day of exposure, but after two weeks they responded only six percent of the time. Incubating herring

gulls (*Larus argentatus*) and great black-backed gulls (*L. marinus*) habituated to the continual presence of humans by modifying their responses, but would continue to be disturbed when they perceived direct approach by a human walking directly toward their nest (Burger and Gochfeld 1981).

Because the occupied elepaio territories at Makua are approximately two times farther from the impact area than the birds studied at Schofield (VanderWerf et al 2000), noise impacts to elepaio at Makua are expected to be less than the impacts at Schofield, and are not expected to adversely affect the reproductive success or survival of Oahu elepaio (VanderWerf *et. al.* 2000).
We were concerned the Oahu elepaio may be exposed to sound levels which are known to cause permanent hearing loss in mammals. Sound levels over 85 dB are considered harmful to inner ear hair cells, 95 dB is considered unsafe for prolonged periods (Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, unpublished). Oahu elepaio may be exposed to sounds which may be loud enough to damage ear hairs. A review of avian hearing loss was conducted and it was determined that hearing loss in birds is difficult to characterize because birds, unlike mammals, regenerate inner ear hair cells, even after substantial loss (Corwin and Cotanche 1988, Stone and Rubel 2000). Therefore, we do not expect permanent hearing loss in Oahu elepaio to result from the proposed action.

Fencing and ungulate control

Browsing by feral goats and rooting by feral pigs has degraded the quality of the primary constituent elements in portions of elepaio critical habitat within the action area by reducing the forest density and inhibiting recruitment of native plants. By completing the ungulate exclusion fence surrounding Makua Valley and removing ungulates from all areas of elepaio critical habitat at Makua, the Army's action will reduce the rate of habitat degradation.

Predator control effects

The primary cause the recent decline of Oahu elepaio appears to nest predation due to rat predation (VanderWerf and Smith 2002). Populations that do not receive rodent control decline at an average rate of 24 percent per year, while sites with rodent control, on average, remain unchanged (VanderWerf and Smith 2002). In 2006, the Army's Natural Resources Staff conducted predator control in 17 elepaio territories at Schofield Barracks West Range, 25 territories at Honouliuli, 14 territories at Makaha, and 26 territories at Moanalua (82 territories total) (U.S. Army 2006). A 24-percent loss of birds in these 82 territories would have resulted in a reduction of 39 birds over a one year period. Predator control efforts within the Makua Action Area have been hampered by unexploded ordinance and other access issues. Completion of the proposed fence, and aerial application of rodenticide at Makua is likely to prevent reductions in elepaio numbers at Makua due to nest predation.

Conclusion

Mortality due to weapons use and wildland fire may result from the proposed action. Grass fires in Makua valley may burn into adjacent forested areas where Oahu elepaio occupy territories. Fires may be ignited within the forested areas by misfired 2.75-caliber rocket, Javelin, and TOW weapons. Weapons restriction, fire suppression helicopter staffing, pre-planning and implementation of suppression actions by skilled NWCG-qualified supervisors, and new fuelbreaks and firebreaks will minimized the risk of fire burning occupied Oahua elepaio territories in the action area. Chemical fire retardants and noise associated with the proposed action are not likely to negatively impact Oahu elepaio. The potential loss of elepaio from the Army's proposed actions will be offset by the ongoing efforts of the Army's Natural Resources Staff as they implement stabilization actions for 28 plant species pursuant to the Makua Implemnetation Plan Addendum. Fencing, feral ungulate removal and rodent control are expected to minimize future reductions in elepaio numbers associated with habitat degradation and nest predation. Based on our analysis of the effects of the actions outlined in the project des ription including fire minimization measures, we believe that no more than one Oahu elepaio pair and one nest will be killed during the next 30 years.

Effects of the Action on Oahu Elepaio Critical Habitat

The Makua action area includes 1,106 hectares (2,734 acres) of Oahu elepaio critical habitat in Unit 1 (66 FR 63752). Elepaio critical habitat in the Makua action area represents approximately four percent of the 26,868 hectares (66,390 acres) designated as critical habitat for this species on the island, and approximately 25 percent of critical habitat Unit 1 (see Figure E 61). The primary constituent elements required by the Oahu elepaio for foraging, sheltering, roosting, nesting, and rearing of young are undeveloped wet, mesic, and dry forest habitats with a closed canopy and a dense understory. In addition, the primary constituent elements associated with the biological needs of dispersal and genetic exchange among populations are undeveloped wet or dry shrub land and wet or dry cliff habitats (Service 2001). Any action that affects structure of the forest canopy or understory has the potential to adversely modify or destroy elepaio critical habitat. Actions that affect the size, distribution, and distance between forested areas have the potential to adversely modify the value of critical habitat for dispersal.

<u>Fires from Current Military Training and Transformation</u>

The potential long-term effects of fire on elepaio critical habitat are serious. Fires destroy forest needed by elepaio for foraging, nesting, and sheltering, thereby reducing the amount of habitat available to elepaio and limiting their population. Fires remove or alter the primary constituent elements of elepaio critical habitat by burning forest altogether, opening the canopy, and thinning the understory. Fires also facilitate the spread of alien plant species not used by elepaio, such as *Casuarina* spp. and *Eucalyptus robusta*, because these species burn readily and grow back more quickly than native plants following a fire. *Eucalyptus* and *Casuarina* forests often prevent the formation of a dense understory.

Of the 1,106 ha (2,734 ac) of elepaio critical habitat in the Makua action area, 178 ha (441 ac) are regarded to have high fire risk, 388 ha (960 ac) are located in the low fire risk zone, and 540 ha (1,333 ac) occur in the very low fire risk zone. In September 2003, a prescribed burn in Makua escaped and burned approximately 61 ha (150 ac) of designated Oahu elepaio critical habitat, including portions of three elepaio territories. Fires also burned forest in this area before it was designated as critical habitat for the elepaio. Fires at Makua that escape the firebreak road primarily burn areas that have burned previously, but each new fire may also extend a short distance into previously unburned areas of mesic forest in elepaio critical habitat, resulting in replacement of native plant species by fire tolerant alien species and expansion of fire prone habitats that do not contain the primary constituent elements needed by elepaio (see General Effects - Fire Suppression). This vegetative replacement reduces the amount of forest habitat suitable for elepaio and limits the potential elepaio population size. If fires continue to burn critical habitat and these areas are not restored, it can be expected that most or all of the elepaio critical habitat at Makua eventually will be converted to open forest, shrubland, or grassland that does not contain the primary constituent elements needed by elepaio for foraging, sheltering, roosting, nesting, and rearing of young, thereby destroying the function of most or all of the critical habitat in Makua Valley. Elepaio may use dry shrub habitat for dispersal among populations, but they do not establish territories in shrub habitat and use it only transiently. If the areas containing the primary constituent elements needed for foraging, sheltering, and nesting are destroyed and no elepaio populations persist, then the function of areas containing the primary constituent elements needed for dispersal among populations also is destroyed. The potential threat to 178 ha (441 ac) of elepaio critical habitat in the Makua action area from the direct and indirect effects of fires caused by military training is high and low to very low in the remaining 928 ha (2,293 ac), but the application of weapons restrictions, fire suppression staffing guidelines, and additional fuelbreaks and firebreaks will minimize the risk of fire to elepaio and elepaio critical habitat areas. In addition, post-fire restoration of any burned elepaio critical habitat areas is expected to ensure that any losses of elepaio habitat would be temporal.

<u>Ungulate control</u>

The browsing of feral goats and the rooting of feral pigs can lead to a long-term loss of forest habitat by reduction in recruitment of canopy tree species and opening of the understory and spread of alien plant species. If feral ungulate populations are not controlled, the habitat quality and primary constituent elements needed by elepaio will be slowly degraded, eventually resulting in complete loss of their value for the conservation of the species. Proposed completion of the ungulate exclosure fence surrounding Makua Valley, removal of ungulates will prevent future ungulate degradation of Oahu elepaio critical habitat in Makua Valley.

<u>Conclusion</u>

While there is a risk of fire impacting Oahu elepaio critical habitat, the Service concludes that there is a greater likelihood that the proposed action will result in overall maintenance of the critical habitat even when fire risk is considered. The risk of adverse modification from training in Makua Military Reservation is low because only four percent of the critical habitat lies within the Action Area. However, critical habitat lands within the Action Area would be an integral part of any viable elepaio population in the northern Waianae Mountains, and are needed to conserve the complete geographic, morphological, and behavioral variation in elepaio across the island. The proposed action is not likely to adversely modify or destroy critical habitat and unlikely to diminish the value of the critical habitat for the conservation of the species. Effective implementation of the weapons restrictions, fire suppression staffing, firebreaks and fuelbreaks, control of feral ungulates and rodents, and post-fire restoration of burned Oahu elepaio critical habitat areas, is expected to prevent destruction or degradation of habitat needed by elepaio for foraging, sheltering, nesting, and dispersing within the Makua action area. This conclusion relies heavily on successful implementation of the conservation actions described above, and the efficacy of these actions in reducing threats must be monitored. If the actions are found not to be effective, the reasons for their ineffectiveness must be rectified and this conclusion must be revisited.

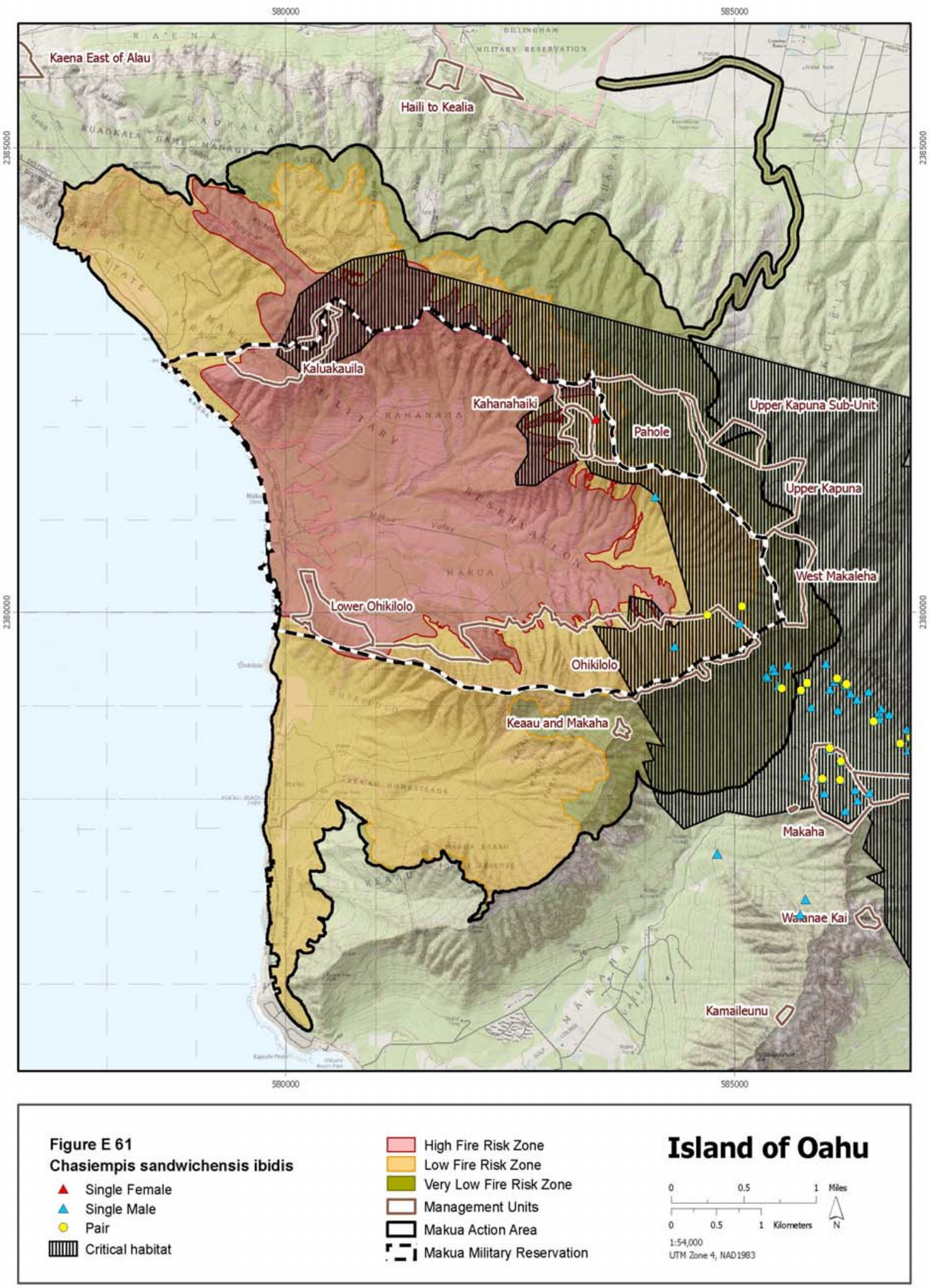

Figure E 61
Chasiempis sandwichensis ibidis

CUMULATIVE EFFECTS

Cumulative effects are those impacts of future State and private actions that are reasonably certain to occur within the area of action subject to consultation. Cumulative effects include the impacts of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Biological Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Endangered Species Act.

Listed resources in the Makua action area are likely to be exposed to stressors associated with fires ignited by local arson incidents or by human carelessness, if these fires spread to population units, management units, or critical habitat within the action area. Brushfires are common throughout leeward Oahu each summer and are reasonably certain to occur in the future. During June through August 2005, for example, brushfires over approximately 2,327 ha (5,750 ac) in the Waianae area (Waianae Valley, Waianae, Maili, and Lualualei) were attributed to arson or fireworks (*Honolulu Advertiser*, January 2, 2006). Non-military fires of unknown origin burned about 405 ha (1,000 ac) in the Keawaula portion of the action area in July 2006 (*Honolulu Advertiser*, July 14, 2006; U.S. Army Garrison 2006b). Non-military fires also have burned parts of Makua Military Reservation from ignitions along Farrington Highway outside the installation (U.S. Army Corps of Engineers 2005). One such fire in July 2006 spread into the Lower Okikilolo Management Unit of Makua, where it burned within 50 m (165 ft) of *Chamaesyce celastroides* var. *kaenana* plants and within 150 m (495 ft) of *Hibiscus brackenridgei* ssp. *mokuleianus* plants. This fire also burned, and likely destroyed, up to 22 *Melanthera tenuifolia* plants in a unique, low-elevation site for this species (U.S. Army Garrison 2006a). Another July 2006 fire burned from along Farrington Highway up to the Kaluakauila Management Unit, where it impacted more than 81 ha (200 ac) that supported experimental reintroductions of *Hibiscus brackenridgei* ssp. *mokuleianus* and natural occurrences of *Chamaesyce celastroides* var. *kaenana* (U.S. Army Garrison 2006d). Loss of individuals and occurrences within population units outside the action area could significantly reduce the available seed source for propagation and outplanting of target and at-risk taxa both within and outside the action area. Cumulative effects related to non-military wildfire will be minimized by the Army's development and implementation of wildland fire management plans for management units on Army lands and adjacent State lands.

Future State actions in the action area include continued management of State lands according to their current designations as Forest Reserves or Natural Area Reserves. The State will continue to manage threatened and endangered species on their lands to the best of their ability. In addition, there will be continued threats to listed species in the action area from feral ungulates because of State regulated hunting activities in Forest Reserves and Game Management Areas.

CONCLUSION

After reviewing the current status of the species and critical habitats, the environmental baseline for species and critical habitat in the action area, and the effects of military training at Makua, including the cumulative effects, it is our biological opinion that implementation of the proposed action is not likely to jeopardize the continued existence of any species covered in this opinion, or adversely modify or destroy designated critical habitat addressed in this opinion. This reinitiation was a risk assessment regarding the potential of a fire igniting and burning species or critical habitat.

The no jeopardy conclusions are based on the following: (1) Army conservation and stewardship programs that will increase the baseline number of individuals pursuant to the criteria stipulated in the Makua Implementation Plan and the Makua Implementation Plan Addendum for 28 species; (2) weapons restrictions, fuels management, fire suppression, and construction of fuelbreaks and firebreaks, to minimize the risk of wildland fire; and (3) invasive species control such as rat baiting, ungulate removal and invasive plant management. Please see each of the species specific conclusion sections in the effects analysis for the basis of how we reached these conclusions.

Our determination that implementation of the proposed action would not adversely modify or destroy critical habitat is based largely on the Army's multiple actions to minimize and reduce the risk of fire, minimize introduction and spread of non-native species, increase the current baseline for primary constituent elements of critical habitat. In addition, if a fire should escape the firebreak road, the affected critical habitat will be restored. Any losses that occur after implementation of these actions will be short term in nature and will not result in permanent destruction or alteration of the physical and biological features of critical habitat. Please see each of the species specific critical habitat conclusion sections in the effects analysis for more specific discussion of how we reached these conclusions.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined (50 CFR 17.3) by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service (50 CFR 17.3) as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Army so that they become binding conditions in order for the exemption in section 7(o)(2) to apply. The Army has a continuing duty to regulate the activity covered by this incidental take statement. If the Army (1) fails to assume and implement the terms and conditions or (2) fails to require any contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any permit or contract, then the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Army must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR § 402.14(i)(3)].

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law (HRS 195D).

Amount or Extent of Take

This Biological Opinion anticipates the following forms of incidental take:

1. The Service anticipates that take will occur in the form of harm (due to the loss of habitat), harassment, and death as a result of Army activities described in this Biological Opinion. The Service anticipates that the loss of no more than one occurrence of *Achatinella mustelina* comprised of 10 to 40 individuals will occur over the next 30 years.

2. The Service anticipates that take will occur in the form of harm (due to the loss of habitat), harassment, and death as a result of Army activities described in this Biological Opinion. The Service anticipates the take of one (1) Oahu elepaio pair and one (1) nest (which may contain up to 3 eggs or 3 nestlings, or a combination of nestlings and eggs not to exceed a total of 3 will occur over the next 30 years.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §703-712), if such take is in compliance with the terms and conditions specified herein.

Effect of Take

In this Biological Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the continued existence of the *Achatinella mustelina* or Oahu elepaio, or destruction or adverse modification of Oahu elepaio critical habitat.

Reasonable and Prudent Measures

The reasonable and prudent measures given below, with their implementing terms and conditions, are designed to minimize the impacts of incidental take that might otherwise result from the proposed actions. If, during the course of the actions, the level of incidental take is exceeded, the action agency is required to reinitiate consultation and review the reasonable and prudent measures provided in this Biological Opinion. In addition, the Army must cease the activities that caused the taking; must immediately provide an explanation of the causes of the taking; and must review with the Service the need for possible modification of the reasonable and prudent measures. The Army will offset unavoidable impacts through the implementation of the conservation measures as described in the Project Description. The Army will implement the conservation measures as identified in the Project Description of this Biological Opinion.

The Service believes the following Reasonable and Prudent Measures are necessary and appropriate to minimize incidental take of *Achatinella mustelina* and Oahu elepaio. The measures described below are non-discretionary and must be implemented.

1. Minimize impacts of military activities and actions on survival and reproduction of *Achatinella mustelina* within the Makua action area.

2. Minimize direct impacts of military activities on survival and reproduction of Oahu elepaio within the Makua action area.

3. Minimize loss of Oahu elepaio habitat within the Makua action area.

4. Minimize threat of alien rats to Oahu elepaio within the Makua action area.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the agency must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1. Minimize impacts of military activities and actions on survival and reproduction of *Achatinella mustelina* within the Makua action area.

   1.1. All enclosures of known tree snail occurrences must be completed within five years of the issuance of the Biological Opinion.

   1.2. The Army will report in writing on an annual basis to the Service on the following items: (1) status of the known occurrences; (2) number and location of high explosives or pyrotechnics that land outside of the impact area; (3) the extent of damage or fires that result from these high explosives or pyrotechnics; and (4) how close to known tree snail occurrences were the high explosive impacts.

   1.3. The Service shall be notified within one (1) working day of any take of *Achatinella mustelina*.

   1.4. The depository designated to receive specimens of *Achatinella mustelina* or shells that are collected is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii, 96817 (telephone: 808/547-3511). If the B.P Bishop Museum does not wish to accession the specimens, the permittee should contact the Service's Division of Law Enforcement in Honolulu, Hawaii (telephone: 808/541-2681; fax: 808/541-3062) for instructions on disposition.

2. Minimize direct impacts of military activities on survival and reproduction of Oahu elepaio within the Makua action area.

   2.1. Prior to initiating live-fire training at Makua, an appendix to this Biological Opinion will be prepared, detailing and clarifying, in text format, the weapons restrictions summarized in Table PD 2. If the Standard Operating Procedures detail the weapons restrictions in text form as well as in tables, completion of revised Standard Operating Procedures would satisfy this provision. The text will be approved by the Service prior to implementation of live-fire training at Makua.

2.2. The Army will notify the Service within 24 hours of any fires that burn any portion of a known elepaio territory and the number of elepaio territories affected.

2.3. The Army will report to the Service quarterly in writing the number of high explosive rounds that land outside the south lobe of the firebreak road, the locations where such rounds land, and whether these locations are within any known elepaio territories

2.4. The depository designated to receive specimens of any Oahu elepaio that are killed is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii, 96817 (telephone: 808/547-3511). If the B.P Bishop Museum does not wish to accession the specimens, the permittee should contact the Service's Division of Law Enforcement in Honolulu, Hawaii (telephone: 808/541-2681; fax: 808/541-3062) for instructions on disposition.

3. Minimize loss of Oahu elepaio habitat within the Makua action area.

3.1. Army Natural Resource Staff will have adequate access and will implement a rat control program, in all occupied Oahu elepaio breeding territories within the Makua action area. Until aerial dispersal of rodenticide is approved, Natural Resources Staff will bait and set a sufficient number of traps and bait stations every one to two weeks during the breeding season to control rat predation.

3.2. The Army will report annually to the Service in writing the number of elepaio territories in which rats were controlled, the location of each territory in which rats were controlled, the methods by which rats were controlled in each territory, the dates on which rat control activities were conducted in each territory, and the status of elepaio in each territory from the previous year.

4. Minimize threat of alien rats to Oahu elepaio within the Makua action area.

4.1. Construction of an ungulate-proof fence encircling the Makua Military Reservation installation boundary will be completed within three years of the date of completion of this Biological Opinion.

4.2. To prepare for aerial dispersal of rodenticide, ungulates will be removed from Makua Military Reservation within five years of the completion of this Biological Opinion.

4.3. The fence will be maintained and Makua Military Reservation will be kept free of ungulates.

4.4. When aerial rodenticide is approved for use, it will be applied in accordance with its label (e.g., fenced and "ungulate-free") for the control of rats throughout the Makua action area and management units outside the action area.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Endangered Species Act (Act) directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The recommendations provided relate only to the proposed action and do not necessarily represent complete fulfillment of the Army's section 7(a)(1) responsibilities for the species. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

1) The Army has an expansive and comprehensive database to document pertinent information regarding each species. We recommend the Army hire an individual to update and maintain the biological database, add additional plant location data, link population unit data with GIS data points.

2) We recommend the Army fund additional invertebrate pest management research to identify effective control or eradication methods for pests of concern such as *Euglandina rosea*, black-twig borer, and slugs.

3) The Army should maintain fire suppression staffing and helicopter availability for rapid deployment to wildland fires in the vicinity of any management unit, inside and outside of the action area, when live herbaceous fuel moisture is below 120 percent. Large fires may develop quickly when the grass is cured and strategic use of limited personnel and helicopter resources will be necessary to ensure the protection of stabilization populations of endangered plants growing in the Waianae Mountains.

4) To facilitate reintroduction and fire suppression planning, Army Natural Resources Staff should add GPS locations of individual plants to their GIS database.

5) To facilitate communications between Makua and wildland firefighters and cooperators stationed outside Makua valley, the Army should install a new radio repeater within range of Makua Valley.

6) The Army should increase nursery facilities with the goal of creating a production-scale facility that is capable of producing large quantities of native plant materials for use in revegetation projects. This native plant stock and seed could be used by the Integrated Training Area Management staff for their revegetation projects. Also, there would be plant materials readily available in case a fire does burn critical habitat and habitat restoration is warranted.

7) The Army should continue to pursue the establishment of shaded fuelbreaks, vegetated by native species, adjacent to existing forest and shrub vegetation, to further minimize fire risk to existing forest areas.

8) The Army should be a Cooperator on the National Environmental Policy Act documents for the registration of the aerial broadcast of a rodenticide for conservation purposes in Hawaii.

9) The Army should establish protocols for hydro-mulching or other large-scale native plant seeding to be used in native habitat restoration efforts.

10) In order to substantially reduce the fire risk associated with live-fire training, close Makua to live-fire training (except for short-range training ammunition blanks used in specified areas) when live herbaceous fuel moisture falls below 100 percent.

REINITIATION STATEMENT

This concludes formal consultation on this action. As required in 50 CFR § 402.16, reinitiation of consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operation causing such take must cease pending reinitiation. The Army will coordinate with the Service if a fire due to military activities or actions occurs outside of any of the firebreak roads established at Makua. No military training activities with live-fire weaponry, except for those that are addressed in this consultation may be used at this installation without coordination with the Service. As stated in the Conclusion (above), the Service's finding of no adverse modification is based in large part on the conservation measures built into the project by the Army. Should there be a failure to carry out any or all of the described measures, or if the measures are not effective, or if these measures are modified in any way without Service coordination, reinitiation of consultation will be required. If you have any questions regarding this Biological Opinion, please contact Ms. Patrice Ashfield of my staff at (808) 792-9400.

Sincerely,

Patrick Leonard

Patrick Leonard
Field Supervisor

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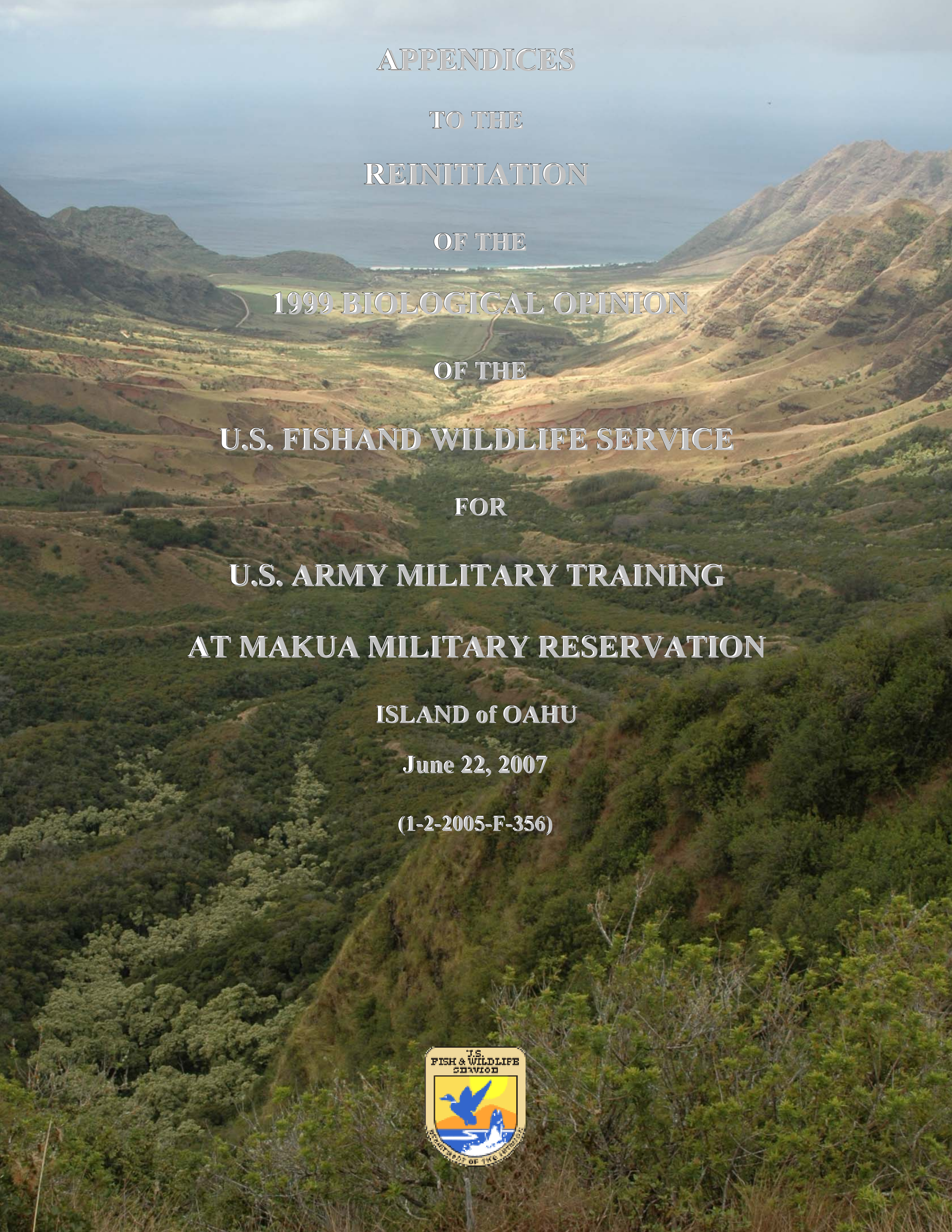


APPENDICES

TO THE

REINITIATION

OF THE

1999 BIOLOGICAL OPINION

OF THE

U.S. FISHAND WILDLIFE SERVICE

FOR

U.S. ARMY MILITARY TRAINING

AT MAKUA MILITARY RESERVATION

ISLAND of OAHU

June 22, 2007

(1-2-2005-F-356)

Appendix A. Threatened and Endangered Species and Critical Habitat Located in the Makua Action Area

Plants

1. *Abutilon sandwicense* - Endangered
2. *Alectryon macrococcus* var. *macrococcus* - Endangered
3. *Bonamia menziesii* - Endangered
4. *Cenchrus agrimonioides* var. agrimonioides - Endangered
5. *Chamaesyce celastroides* var. *kaenana* - Endangered
6. *Chamaesyce herbstii* - Endangered
7. *Ctenitis squamigera* - Endangered
8. *Cyanea grimesiana* ssp. *obatae* - Endangered
9. *Cyanea longiflora* - Endangered
10. *Cyanea superba* ssp. *superba* - Endangered
11. *Cyrtandra dentata* - Endangered
12. *Delissea subcordata* - Endangered
13. *Diellia falcata* - Endangered
14. *Dubautia herbstobatae* - Endangered
15. *Euphorbia haeleeleana* - Endangered
16. *Flueggea neowawraea* - Endangered
17. *Gouania vitifolia* - Endangered
18. *Hedyotis degeneri var. degeneri* - Endangered
19. *Hedyotis parvula* - Endangered
20. *Hesperomannia arbuscula* - Endangered
21. *Hibiscus brackenridegei* ssp. *mokuleianus* - Endangered
22. *Lobelia niihauensis* - Endangered
23. *Melanthera tenuifolia* (*Lipochaeta tenuifolia*) - Endangered
24. *Neraudia angulata* - Endangered
25. *Nototrichium humile* - Endangered
26. *Peucedanum sandwicense* - Threatened
27. *Phyllostegia kaalaensis* - Endangered
28. *Plantago princeps var. princeps* - Endangered
29. *Pritchardia kaalae* - Endangered
30. *Sanicula mariversa* - Endangered
31. *Schiedea hookeri* - Endangered
32. *Schiedea kaalae* - Endangered
33. *Schiedea nuttallii* - Endangered
34. *Schiedea obovata* (*Alsinidendron obovatum*)- Endangered
35. *Silene lanceolata* - Endangered
36. *Spermolepis hawaiiensis* - Endangered
37. *Tetramolopium filiforme* - Endangered
38. *Viola chamissoniana* ssp. *chamissoniana* - Endangered

Animals

1.	*Achatinella mustelina* - Endangered	Oahu tree snail
2.	*Chasiempis sandwichensis ibidis* - Endangered	Oahu elepaio

Appendix A. continued.

<u>Plant Critical Habitat</u>

1. *Bonamia menziesii*
2. *Cenchrus agrimonioides* var. *agrimonioides*
3. *Chamaesyce celastroides* var. *kaenana*
4. *Chamaesyce herbstii*
5. *Colubrina oppositifolia*
6. *Cyanea grimesiana* ssp. *obatae*
7. *Cyanea longiflora*
8. *Cyanea superba* ssp. *superba*
9. *Cyrtandra dentata*
10. *Delissea subcordata*
11. *Diellia falcata*
12. *Dubautia herbstobatae*
13. *Euphorbia haeleeleana*
14. *Flueggea neowawraea*
15. *Gouania vitifolia*
16. *Hedyotis degeneri* var. *degeneri*
17. *Hedyotis parvula*
18. *Hesperomannia arbuscula*
19. *Hibiscus brackenridgei* ssp. *mokuleianus*
20. *Isodendrion laurifolium*
21. *Isodendrion longifolium*
22. *Isodendrion pyrifolium*
23. *Mariscus pennatiformis*
24. *Melanthera tenuifolia*
25. *Melicope pallida*
26. *Neraudia angulata*
27. *Nototrichium humile*
28. *Phyllostegia kaalaensis*
29. *Plantago princeps* var. *Princeps*
30. *Sanicula mariversa*
31. *Schiedea hookeri*
32. *Schiedea kaalae*
33. *Schiedea nuttallii*
34. *Schiedea obovata*
35. *Solanum sandwicense*
36. *Spermolepis hawaiiensis*

<u>Animal Critical Habitat</u>

1. *Chasiempis sandwichensis ibidis* Oahu elepaio

Appendix B. Name and Agency Affiliation of Makua Consultation Participants

Name	Agency	Title
Ashfield, Patrice	USFWS	Technical Assistant and Section 7 Consultation Program Leader
Beavers, Andrew	Center for Environmental Management of Military Lands	Fire and Ecology Management Specialist
Bennett, Stephanie	USFWS	Fish and Wildlife Biologist
Bergmannis, Colleen	U.S. ARMY	Army ITAM
Borja, Bert	U.S. ARMY	Makua Range Control Supervisor
Boulet, Bill	U.S. ARMY	Installation Fire and Safety Office
Ching, Susan	U.S. ARMY	Army Natural Resources Biologist
Costales, Pat	DLNR, DOFAW	Oahu District Manager
Dang, Charmie	USFWS	Fish and Wildlife Biologist
Enriques, Gayland	U.S. ARMY	Army Fire Chief
Fujioka, Francis M.	USDA Forest Service	Research Meteorologist
Godfrey, Joel	U.S. ARMY	Chief, Environmental Division
Greenlee, Dawn	USFWS	Fish and Wildlife Biologist
Greenlee, Jason	U.S. ARMY	Army Wildlife Fire Management Officer (2005 – 2006)
Houseberg, Sammy	U.S. ARMY	Director, Installation Fire and Safety Office
Huseman, Tom	U.S. ARMY	Makua Range Manager
Kauffman, Boone	USDA Forest Service	Director & Research Ecologist
Kawelo, Kapua	U.S. ARMY	Army Natural Resources Biologist
Killian, Howard J.	U.S. ARMY	Garrison Commander
Mansker, Michelle	U.S. ARMY	Environmental Resource Manger
McBride, Jenness	USFWS	Fish and Wildlife Biologist
Moller, Eric	U.S. ARMY	Army Fire Chief
Oberholtzer, Steve	USFWS	Acting Deputy Field Supervisor
Onaga, Elena	U.S. ARMY	Army Solicitor
Petrovia, Sal	U.S. ARMY	G3 Training
Piskel, Tom	U.S. ARMY	Army Civilian Contractor
Powell, Jeffrey	National Weather Service	Fire Weather Meteorologist
Rubinoff, Ray	U.S. ARMY	Washington Office
Rydell, Nezettte	National Weather Service	Warning Coordination Meteorologist
Shultz, Gina	USFWS	Assistant Field Supervisor
Yuh, Peter	U.S. ARMY	NEPA Coordinator
Walcott, Patty	USFWS	Fish and Wildlife Biologist
Yamasaki, Scott	U.S. ARMY	Army Wildland Fire Management Officer

Appendix C. Plant and Animal Species Mentioned in the Biological Opinion

Scientific Name	Common Nomenclature
Abutilon sandwicense (end)[1]	--
Acacia confusa (nat)[2]	Formosan koa
Acacia koa (end)	koa
Acacia koaia (end)	koaia
Acacia mearnsii (nat)	Black wattle
Achatina fulica (nat)	giant African snail
Achatinella (end)	tree snail
Achatinella mustelina (end)	Oahu tree snail; pupu kani oe
Achatinella bellula (end)	Oahu tree snail; pupu kani oe
Achatinella viridans (end)	Oahu tree snail; pupu kani oe
Achyranthes aspera	Prickly achyranthes
Achyranthes sp. (end)	--
Achyranthes splendens (end)	hinahina ewa
Adoretus sinicus (nat)	Chinese rose beetle
Ageratina riparia (nat)	spreading mist flower; hamakua pamakani
Ageratum conyzoides	maile honohono
Alectryon macrococcus (end)	mahoe
Alectryon macrococcus ssp. *auwahiensis* (end)	mahoe
Alectryon macrococcus ssp. *macrococcus* (end)	mahoe
Aleurites moluccana (pol)[3]	kukui
Aleurodicus dugesii	giant whitefly
Alsinidendron (end)	--
Alsinidendron obovatum (end)	--
Alyxia oliviformis (end)	maile
Andropogon virginicus (nat)	broomsedge
Anoplolepis longipes (nat)	long legged ant
Antidesma platyphyllum (and)	hame
Antidesma platyphyllum var. *hillebrandii* (end)	hame
Antidesma pulvinatum (end)	hame
Antidesma sp. (end)	hame
Araucaria columnaris (nat)	Cook pine
Argemone glauca (end)	prickly poppy, pua-kala
Artemisia australis (end)	ahinahina, hinahina, hinahina kuahiwi
Asplenium kaulfussii (end)	kuau
Asplenium lobulatum (end)	pii pii lau manamana, analii
Asplenium macraei (end)	iwaiwa lau lii
Asplenium unilaterale (end)	pamoho
Astelia sp. (end)	painiu
Axis axis (nat)	axis deer
Bidens amplectens (end)	kookoolau
Bidens cervicatai (end)	kookoolau
Bidens hawaiensis (end)	kookoolau
Bidens sp. (end)	kookoolau
Bidens torta (end)	kookoolau

Appendix C. Continued.

Blechnum appendiculatum (nat)	--
Bobea brevipes (end)	ahakea lau lii, akupa
Bobea elatior (end)	ahakea lau nui
Bobea sp. (end)	ahakea
Boehmeria grandis (end)	akolea
Boerhavia sp. (end)	alena, anena, nena
Boiga irregularis	brown tree snake
Bonamia menziesii (end)	--
Bos taurus (nat)	cattle
Bradybaena similaris (nat)	small garden snail
Canavalia sp. (end)	awikiwiki
Capra hircus (nat)	goat
Carex sp. (end)	--
Carex wahuensis (end)	--
Casuarina glauca (nat)	Longleaf ironwood
Casuarina sp. (nat)	ironwood
Cenchrus agrimonioides (end)	kamanomano
Cenchrus agrimonioides ssp. *agrimonioides* (end)	kamanomano
Chamaesyce celastroides (end)	akoko
Chamaesyce celastroides ssp. *kaenana* (end)	akoko
Chamaesyce celastroides var. *amplectensi* (end)	akoko
Chamaesyce celastroides var. *hanapepensis* (end)	akoko
Chamaesyce celastroides var. *lorifolia* (end)	akoko
Chamaesyce herbstii (end)	akoko
Chamaesyce multiformis (end)	akoko
Chamaesyce sp. (end)	akoko
Charpentiera obovata (end)	papala
Charpentiera sp. (end)	papala
Charpentiera tomentosa (end)	papala
Chasiempis sandwichensis ibidis (end)	Oahu elepaio
Cibotium chamissoi (end)	hapuu
Cibotium sp. (end)	hapuu
Cirsium vulgare (nat)	Bull thistle
Claoxylon sandwicense (end)	poola
Clidemia hirta (nat)	Koster's curse
Cocculus sp. (end)	huehue
Coccus hespericlum(nat)	soft brown scale insect
Colubrina oppositifolia (end)	kauila
Copestylum chalybescens (nat)	(Diptera: Syrphidae); syrphid fly
Coprosma foliosa (end)	pilo
Coprosma granadensis (end)	makole
Coprosma sp. (end)	pilo
Cordyline fruticosa (pol)	ti, ki
Ctenitis squamigera (end)	pauoa
Culex quinquefasciatus (nat)	southern house mosquito, night biters

Appendix C. Continued.

Cyanea grimesiana (end)	haha
Cyanea grimesiana ssp. *grimesiana* (end)	haha
Cyanea grimesiana ssp. *obatae* (end)	haha
Cyanea longiflora (end)	haha
Cyanea membranacea (end)	haha
Cyanea sp. (end)	haha
Cyanea superba (end)	haha
Cyanea superba ssp. *superba* (end)	haha
Cyrtandra calpidicarpa (end)	haiwale
Cyrtandra dentata (end)	haiwale
Cyrtandra grandiflora (end)	haiwale
Cyrtandra sp. (end)	haiwale
Cyrtandra waianaeensis (end)	haiwale
Delissea subcordata (end)	oha
Desmodium intortum (nat)	Tick clover
Dianella sandwicensis (end)	ukiuki
Dicranopteris (end)	uluhe
Dicranopteris linearis (end)	uluhe
Diellia falcata (end)	--
Diellia unisora (end)	--
Diospyros hillebrandii (end)	lama
Diospyros sandwicense (end)	lama
Diospyros sp. (end)	lama
Diplazium arnottii (end)	hoio pahole
Diplazium sandwichianum (end)	hoio, pohole
Dodonaea viscosa (end)	aalii
Doodia kunthiana (end)	okupukupu, pamoho, okupukupu lau ii
Doodia sp. (end)	okupukupu, pamoho, okupukupu lau ii
Doryopteris sp. (end)	--
Dryopteris sp.(end)	--
Dryopteris unidentata (end)	akole
Dubautia herbstobatae (end)	naenae
Dubautia plantaginea (end)	naenae
Dubautia sp. (end)	naenae
Elaeocarpus bifidus (end)	kalia
Ehrharta stipoides	Meadow rice grass
Erigeron karvinskianus (nat)	daisy fleabane
Erythrina sandwicensis (end)	wiliwili
Eucalyptus robusta (nat)	swamp mahogany
Eugenia reinwardtiana (end)	nioi
Eugenia sp. (end)	nioi
Euglandina rosea (nat)	cannibal snail
Euphorbia haeleeleana (end)	akoko
Felis catus (nat)	feral cat
Ficus macrophylla (nat)	Moreton Bay fig

Appendix C.   Continued.

Ficus microcarpa (nat)	Chinese banyan
Flueggea neowawraea (end)	mehamehame
Freycinetia arborea (end)	ieie
Fusarium oxysporum f. sp. *koae*	Koa wilt
Gahnia beecheyi (end)	--
Gahnia sp. (end)	--
Geoplana septemlineata	centipede worm, predatory flat worm
Gossypium tomentosum (end)	mao
Gouania hillebrandii (end)	--
Gouania vitifolia (end)	--
Grevillea robusta (nat)	silk oak, silver oak
Hedyotis acuminata (end)	au, pilo
Hedyotis degeneri var. *degeneri* (end)	--
Hedyotis parvula (end)	--
Hedyotis schlechtendahliana (end)	kopa
Hedyotis sp. (end)	--
Hedyotis terminalis (end)	manono
Heliothrips haemorrhoidalis (nat)	greenhouse thrips
Helix aspersa (nat)	brown garden snail
Herpestes auropunctatus (nat)	small Indian mongoose
Hesperomannia arbuscula (end)	--
Hibiscus arnottianus (end)	kokio keokeo, hau hele, kokio kea, pamakani
Hibiscus arnottianus var. *arnottianus* (end)	kokio keokeo, hau hele, kokio kea, pamakani
Hibiscus brackenridgei (end)	mao hau hele
Hibiscus brackenridgei ssp. *brackenridgei* (end)	mao hau hele
Hibiscus brackenridgei ssp. *mokuleianus* (end)	mao hau hele
Hibiscus brackenridgei ssp. *molokaiana* (end)	mao hau hele
Hibiscus sp. (end)	kokio, hibiscus
Homalodisca coagulata	glassy winged sharpshooter
Ilex anomala (end)	kawau
Isachne pallens (end)	--
Isodendrion laurifolium (end)	aupaka
Isodendrion longifolium (end)	aupaka
Isodendrion pyrifolium (end)	aupaka
Jacquemontia ovalifolia ssp. *sandwicensis* (end)	pauohiiaka
Kalanchoe pinnata (nat)	air plant
Lantana camara (nat)	lantana, lakana
Leonotis nepetifolia	lion's ear
Lepidium arbuscula (end)	--
Lepidium bidentatum (end)	anaunau
Leptecophylla tameiameiae (end)	pukiawe
Leptospermum scoparium (nat)	New Zealand tea tree
Leucaena leucocephala (nat)	koa haole

Appendix C. Continued.

Lipochaeta lobata (end)	nehe
Lipochaeta sp. (end)	nehe
Lipochaeta tenuifolia (end)	nehe
Lobelia gaudichaudii	--
Lobelia niihauensis (end)	--
Lobelia yuccoides (end)	panaunau
Lysimachia hillebrandii (end)	kolokolo kuahiwi, pua hekili
Lysimachia sp. (end)	--
Machaerina sp. (end)	uki
Mangifera indica (nat)	mango
Mariscus pennatiformis (end)	--
Melanthera remyi (end)	nehe
Melanthera tenuis (end)	nehe
Melanthera tenuifolia (end)	nehe
Melicope pallida (end)	alani
Melicope sp. (end)	alani
Melinis minutiflora (nat)	molasses grass
Metaleurodicus cardini	Cardin's whitefly
Metrosideros polymorpha (end)	ohia, ohia lehua, lehua
Metrosideros rugosa (end)	lehua papa
Metrosideros sp. (end)	ohia, ohia lehua, lehua
Metrosideros tremuloides (end)	lehua ahihi, ahihi, ahiki ku ma kua
Morinda trimera (end)	noni kuahiwi
Mus domesticus (nat)	mice
Myndus crudus (nat)	sap-sucking plant hopper
Myoporum sandwicense (end)	naio, bastard sandalwood
Myrsine lanaiensis (end)	kolea
Myrsine lessertiana (end)	kolea lau nui
Myrsine linearifolia (end)	kolea
Myrsine sp. (end)	kolea
Nephrolepis exaltata (end)	nianiau, okupukupu
Neraudia angulata (end)	--
Neraudia melastomifolia (end)	maaloa
Neraudia sp. (end)	--
Nestegis sandwicensis (end)	olopua
Nothocestrum longifolium (end)	aiea
Nothocestrum sp. (end)	aiea
Nototrichium humile (end)	kului
Nototrichium sandwicense (end)	kului
Nototrichium sp. (end)	kului
Osteomeles anthyllidifolia (end)	ulei, eluehe
Ovis aries (nat)	sheep
Ovis musimon (nat)	mouflon sheep
Oxychilus alliarius	garlic snail
Panicum maximum (nat)	Guinea grass

Appendix C.   Continued.

Partulina sp. (end)	tree snail
Paspalum conjugatum (nat)	Hilo grass, mauu hilo
Passiflora suberosa (nat)	huehue haole
Passiflora tarminiana (nat)	banana poka
Pennisetum setaceum (nat)	fountain grass
Peperomia sp. (end)	ala ala wai nui
Perrottetia sandwicensis (end)	olomea
Peucedanum sandwicense (end)	makou
Phyllostegia kaalaensis (end)	--
Physomerus grossipes (nat)	--
Pilea peploides (end)	--
Pipturus albidus (end)	mamaki
Pipturus sp. (end)	mamaki
Pisonia brunoniana (end)	papala kepau
Pisonia sandwicensis (end)	aulu, kaulu
Pisonia sp. (end)	papala kepau
Pisonia umbellifera (end)	papala kepau
Pittosporum sp. (end)	hoawa
Plantago princeps (end)	laukahi kuahiwi
Plantago princeps var. *anomala* (end)	ale
Plantago princeps var. *laxiflora* (end)	ale
Plantago princeps var. *longibracteata* (end)	ale
Plantago princeps var. *princeps* (end)	ale
Plasmodium relictum (nat)	avian malaria
Platydemus manokwari (nat)	predatory flatworm
Plectranthus parviflorus (end)	alaala wai nui
Pleomele halapepe (end)	hala pepe
Pleomele sp. (end)	hala pepe
Plumbago zeylanica (end)	iliee
Pouteria sandwicensis (end)	alaa
Poxvirus avium (nat)	avian pox
Pritchardia kaalae (end)	loulu
Pritchardia sp. (end)	loulu
Psidium cattleianum (nat)	strawberry guava
Psidium guajava (nat)	common guava
Psidium sp. (nat)	guava
Psilotum nudum (end)	moa
Psychotria hathewayi (end)	kopiko
Psychotria mariniana (end)	kopiko
Psychotria sp. (end)	kopiko
Psydrax odorata (end)	alahee, ohee, walahee
Pteralyxia sp. (end)	kaulu
Pterolepis glomerata (nat)	--
Puccinia psidii	Ohia rust
Pulvinaria psidii	green shield scale insect

Appendix C. Continued.

Quadrastichus erythrinae	Erythrina gall wasp
Rattus exulans (pol)	Polynesian rat, Pacific rat
Rattus norvegicus (nat)	Norway rat, brown rat, sewer rat
Rattus rattus (nat)	black rat, roof rat, ship rat
Rauvolfia sandwicensis (end)	hao
Rivina sp. (nat)	rouge plant
Rubus argutus (nat)	blackberry
Rumex albescens (end)	huahuako
Rumex sp (end)	--
Sanicula mariversa (end)	--
Santalum ellipticum (end)	coastal sandalwood, iliahi
Santalum freycinetianum (end)	iliahi
Santalum sp. (end)	iliahi
Sapindus oahuensis (end)	lonomea
Scaevola glabra (end)	ohe naupaka
Scaevola kilaueae (end)	naupaka
Schiedea hookeri (end)	--
Schiedea kaalae (end)	--
Schiedea mannii (end)	--
Schiedea nuttallii (end)	--
Schiedea obovata (end)	--
Schiedea pentandra (end)	--
Schiedea sp. (end)	--
Schinus terebinthifolius (nat)	Christmas berry
Selaginella arbuscula (end)	lepelepe a moa
Sicyos sp. (end)	anunu
Sida fallax (end)	ilima
Silene lanceolata (end)	--
Smilax melastomifolia (end)	hoi kuahiwi, akaawa
Solanum sandwicense (end)	aieakeakua, popolo
Sophonia rufofascia	two-spotted leafhopper
Sophora chrysophylla (end)	mamane
Spermolepis hawaiiensis (end)	--
Stachytarpheta australis (nat)	oi, owi
Stenogyne sp. (end)	--
Streblus pendulinus (end)	aiai
Sus scrofa (nat)	pig
Syzygium cumini (nat)	Java plum
Syzgium jambos (pol)	Mountain apple
Syzygium sandwicensis (end)	ohia ha
Tecoma capensis (nat)	Cape honeysucke
Tetramolopium filiforme (end)	--
Tetramolopium sp. (end)	--
Tetraplasandra sp. (end)	ohe
Thysanococcus pandani	hala scale insect

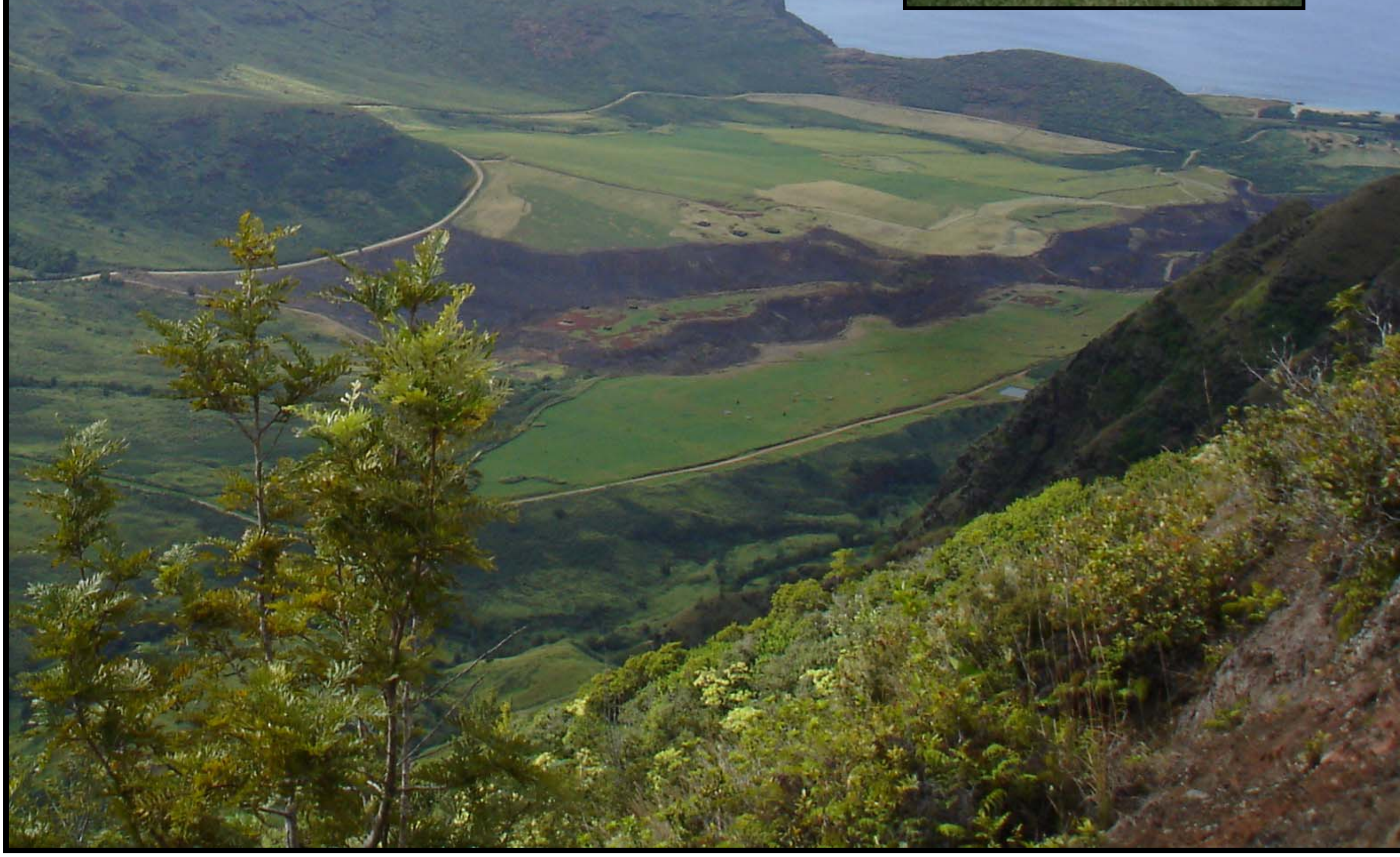
Appendix C. Continued.

Toona ciliata (nat)	Australian red cedar
Triumfetta semitriloba (nat)	Sacramento bur
Urera glabra (end)	opuhe
Vaginulus plebeian (nat)	slug
Veronicella cubensis (nat)	slug
Veronicella leydigi (nat)	black slug
Viola chamissoniana ssp. *chamissoniana* (end)	pamakani
Viola sp. (end)	pamakani
Waltheria indica (end)	uhaloa, alaalapuloa
Wikstroemia oahuensis (end)	akia
Xyleborus affinis (end)	scolytid beetle
Xyleborus crassiusculus (end)	scolytid beetle
Xyleborus fornicatus (end)	scolytid beetle
Xylosandrus compactus (nat)	black twig borer
Xylosma crenatum (end)	--
Xylosma hawaiiense (end)	maua
Xylosma sp. (end)	maua

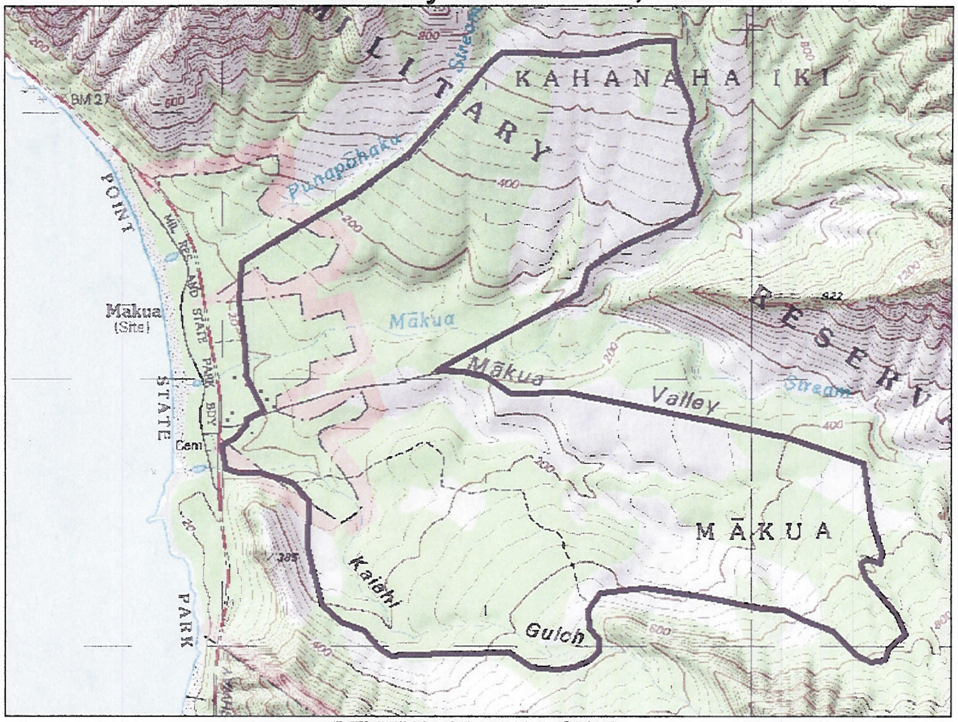
[1]endemic/ indigenous; [2]naturalized; [3]Polynesian introduced

Appendix D

PRESCRIBED BURN PLAN MMR 06-03
Makua Military Reservation, Oahu



PRESCRIBED BURN PLAN MMR 06-03
Makua Military Reservation, Oahu



REVIEW AND APPROVAL

As required under Section 4.4.6, Prescribed Fire Requirements, of the Integrated Wildland Fire Management Plan (IWFMP), Dated October 2003, the proposed burn described in this plan is necessary to achieve the specific management objectives of the Wildfire Management Program.

Prepared by: ______________________ Date December 11, 2006
JASON M. GREENLEE, RXB2
Wildland Fire Management Officer, USARHAW

Reviewed by: ______________________ Date 12/12/06
ERIC MOLLER
Acting Fire Chief, Installation Fire and Safety Office

Reviewed by: ______________________ Date 12/12/06
VICTOR GARO, JR.
Range Officer, G3/DPTM, Range Division

Reviewed by: for ______________________ Date 12/12/06
GLEN DELAURA
Fire Chief, Federal Fire Department

Approved by: ______________________ Date 12/12/06
SAMMY C. HOUSEBERG
Director, Installation Fire and Safety Office

PRESCRIBED BURN PLAN MMR 06-03
Makua Military Range

Table of Contents

AGENCY ADMINISTRATOR / PRESCRIBED FIRE MANAGER'S GO/NO-GO PRE-IGNITION APPROVAL CHECKLIST

Instructions: The Prescribed Fire Manager's GO/NO-GO Pre-Ignition Approval is completed before a prescribed fire can be implemented. This Approval evaluates whether compliance requirements, Prescribed Burn Plan elements, and internal and external notifications have been completed and expresses the Prescribed Fire Manager's intent to implement the Prescribed Burn Plan. If ignition of the prescribed fire is not initiated prior to expiration date determined by the Prescribed Fire Manager's, a new approval will be required.

Yes	No	Key Element Questions
		Is the Prescribed Burn Plan up to date? *Hints: amendments, seasonality, Service concurrence to alterations.*
		Have all compliance requirements been completed? *Hints: Cultural, threatened and endangered species, smoke management, NEPA.*
		Is risk management in place and the residual risk acceptable? *Hints: Is the Prescribed Fire Complexity Rating Guide completed with rational and mitigation measures identified and documented?*
		Will all elements of the Prescribed Fire Plan be met? *Hints: Preparation work, mitigation, weather, organization, prescription, contingency resources*
		Will all internal and external notifications and media releases be completed? *Hints: Preparedness level restrictions*
		Are key agency staff fully briefed and understand prescribed fire implementation?
		Other:

The approved prescribed fire plan constitutes a delegation of authority to burn. No one has the authority to burn without an approved plan or in a manner not in compliance with the approved plan. Actions taken in compliance with the approved plan will be fully supported by management. Personnel will be held accountable for actions taken which are not in compliance with the approved plan regarding execution in a safe and cost-effective manner. The document attached is a complete catalog of all documentation expected other than training records, red cards, and work capacity test records, which will be maintained and kept available at the Army wildland fire office. Trainers will be held accountable for actions taken by trainees in their capacity as a trainee. Contingency forces will be sufficient to contain a fire provided weather forecast and actual weather are in-prescription. The Burn Boss will make every effort to obtain reliable long-range and spot weather forecasts. If a weather event occurs that is not forecast, the resources in this plan may not be able to contain a spot fire and additional resources will be ordered. The approving line officer delegates the responsibility to declare an escape fire to the Prescribed Fire Burn Boss.

Approved by: ____ Date: ___________
_________________________, Agency Administrator

Approval expires (date): ____________________________________

TRANSFER OF RESPONSIBILITY

As the prescribed fire progresses from ignition and holding to extended days of mop up, the complexity of the burn decreases and the Burn Boss may transfer responsibility for this burn to a qualified Incident Commander or Burn Boss with NWCG qualifications commensurate with the complexity of the fire. Once the fire is no longer spreading and the outer edges have been mopped up, the fire may be transferred to an NWCG-qualified Incident Commander with qualifications commensurate with the complexity of the fire. The burn will not be transferred to an incident commander or burn boss with qualifications lower than RXB3 or ICT4 until the outer 20 meters of the burn unit have been mopped up 100 percent. The Burn Boss and Incident Commander will always meet all NWCG qualification prerequisites, including training and task book completion. The NWCG incident commander may not necessarily be employed by the US Army, but may be from a cooperating agency which fully participates in the NWCG red-card system (USFS, USFWS, BLM, BIA, NPS). The fire will be attended to by an on-site NWCG-qualified incident commander until the outer 60 meters have been mopped up. The fire will be assigned to an NWCG-qualified red-carded Incident Commander until it is declared out by the Army Wildland Fire Management Officer or Assistant Wildland Fire Management Officer.

Transfer of responsibility for this burn is being made at this time. I have thoroughly briefed the incoming Burn Boss or Incident Commander, and have insured his/her qualifications are current and that it is safe to make this transfer.

Signed: ______________________ Qualification: _________ Date: _________ Time: _______
Outgoing Burn Boss

Signed: ______________________ Qualification: _________ Date: _________ Time: ______
Incoming Incident Commander

Signed: ______________________ Qualification: _________ Date: _________ Time: ______
Incoming Incident Commander

Signed: ______________________ Qualification: _________ Date: _________ Time: ______
Incoming Incident Commander

Signed: ______________________ Qualification: _________ Date: _________ Time: ______
Incoming Incident Commander

CERTIFICATION THAT FIRE IS OUT

This certifies that the fire is out. Certification must be done by NWCG RXB2 or ICT4 Army Wildland Fire Management Officer or Assistant Wildland Fire Management Officer.

Signed: ______________________ Title: ________________ Date: _________ Time: _______

SECTION 2
DESCRIPTION OF THE BURN AREA

A. Category

(x) Broadcast burn (natural fuels)
(   ) Pile burn
(   ) Logging slash
(x) Fuel break maintenance
(x) Fuel reduction burn for fire hazard reduction, and/or ground visibility for archeological and/or UXO surveys
(   ) Other (specify)

B. Location Entirely within the north and south lobes of the firebreak road.

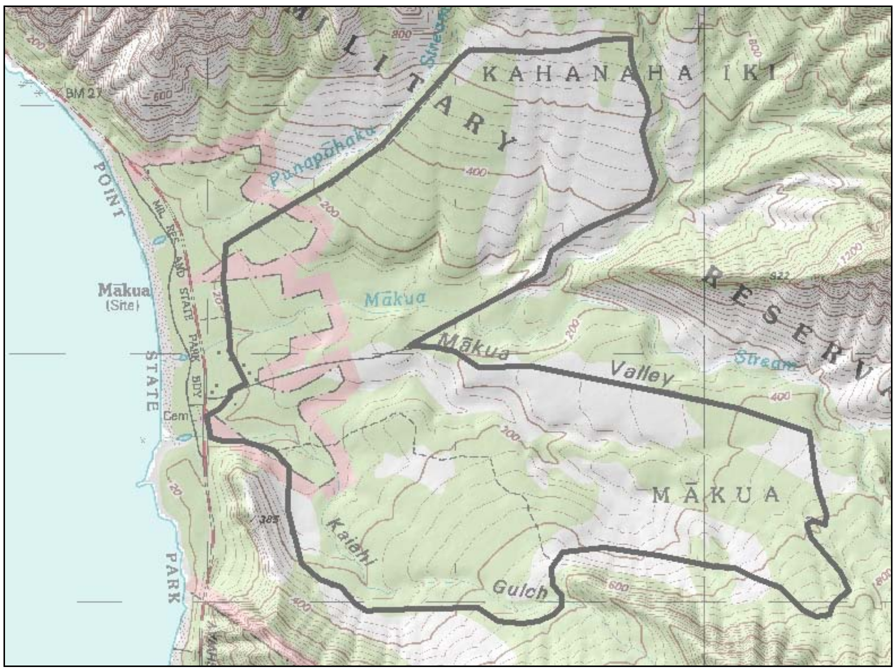


Figure 1: Prescribed Burn Areas: Inside North and South Lobes of the firebreak road system.

C. Size:	800 acres. The burn unit may be partitioned in order to burn smaller blocks.
Elevations:	20-800 feet
Slope:	0 to 45%
Aspect(s):	South and West
F. Vegetation and Fuel	1. <u>Current vegetation:</u> Vegetation to be burned is desiccated guinea grass (*Panicum maximum)*. Surrounding vegetation is also guinea grass, plus molasses grass and haole koa. The National Fire Behavior Fuel Model NFDRS model N has been adapted into a custom guinea grass fuel model called Grass2. Total fuel loading is approximately 10 tons/acre

	Vegetation	Fuel Model
Inside burn area:	Desiccated Gr.	Grass2 (custom)
Outside burn area:	Green Grass	Grass2 (custom)

Canopy height: 3-10 feet

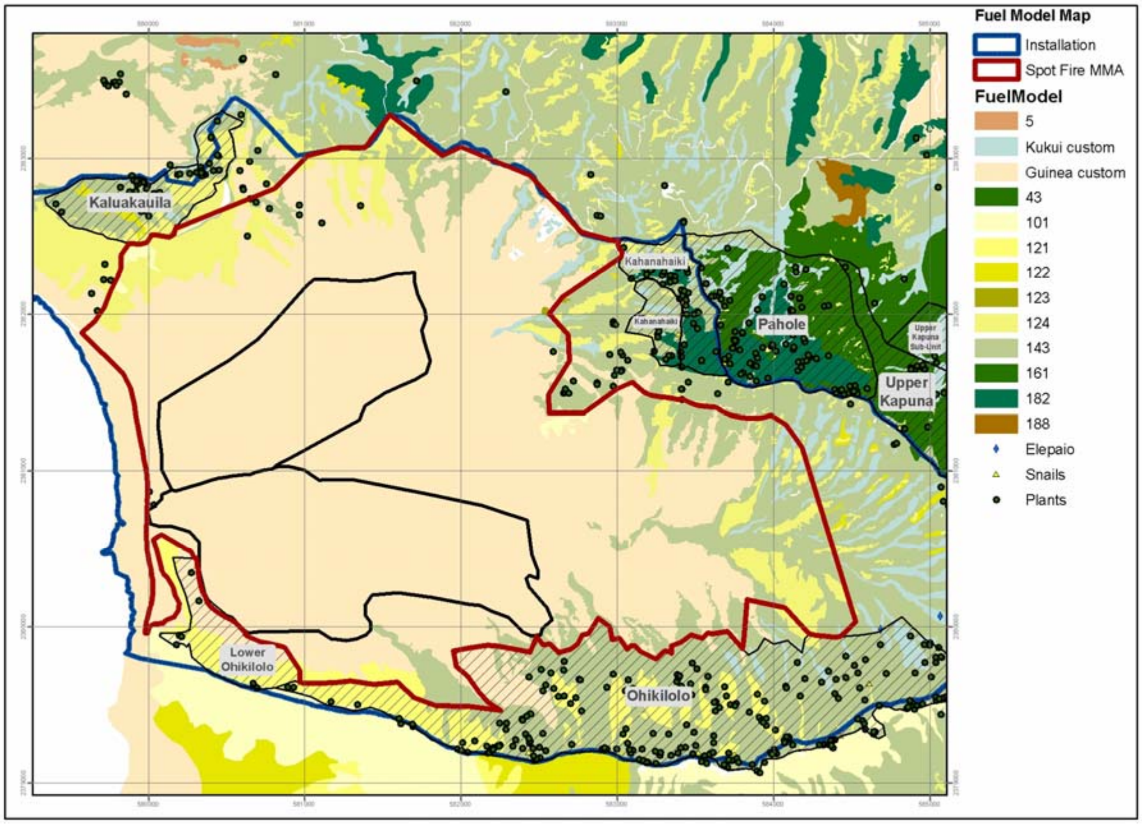


Figure 2. Fuel Model Map.

2. <u>Past environmental and land management history that has impacted the past and present vegetation.</u>

Hawaii has a fire history that is characterized by infrequent lightning fires. *Panicum maximum* (guinea grass) was introduced as a forage grass for cattle ranching. The grass dominates the burn unit and the contingency areas adjacent to the burn unit.

3. <u>Fuel</u>

Fuel inside and outside the firebreak road is dominated by guinea grass. Fuel model parameters for the custom guinea grass fuel model are described in the prescription element of this plan. A custom Kukui fuel model, developed by Beavers, is also used in the vicinity of the burn unit. Other fuel models are standard models described in Scott and Burgan (2005). Areas within the burn unit may be treated with herbicide or otherwise pre-treated to better ensure that treatment objectives are met under relatively cool prescribed burning conditions.

G. Unit Description

Burn units lie entirely within well maintained firebreak roads. The firebreaks are bare mineral soil to a width of six meters. The south lobe of the firebreak road is bisected by several secondary roads. On the slopes and ridges above the burn area, a number of endangered species, both plant and animal, are known to occur. A spot fire which burns any endangered species or forested vegetation within any Management Unit (for instance Ohikilolo, Lower Ohikilolo, Kaluakauila, or Kahanahaiki) or designated critical habitat area would be considered an escaped prescribed burn and would require expensive post-fire restoration work. Measures will be taken to minimize the potential for spot fire occurrence and to minimize spot fire size. However, the Maximum Manageable Area (MMA) does provide for a potential maximum spot fire size of 88 acres. This spot fire would burn in grass fuels outside the firebreak road and would not burn endangered species or critical habitats within Management Units.

I. Endangered Species and Designated Critical Habitat

Figure 3 shows the threatened and endangered species, management units, and designated critical habitat areas to be protected from fire.

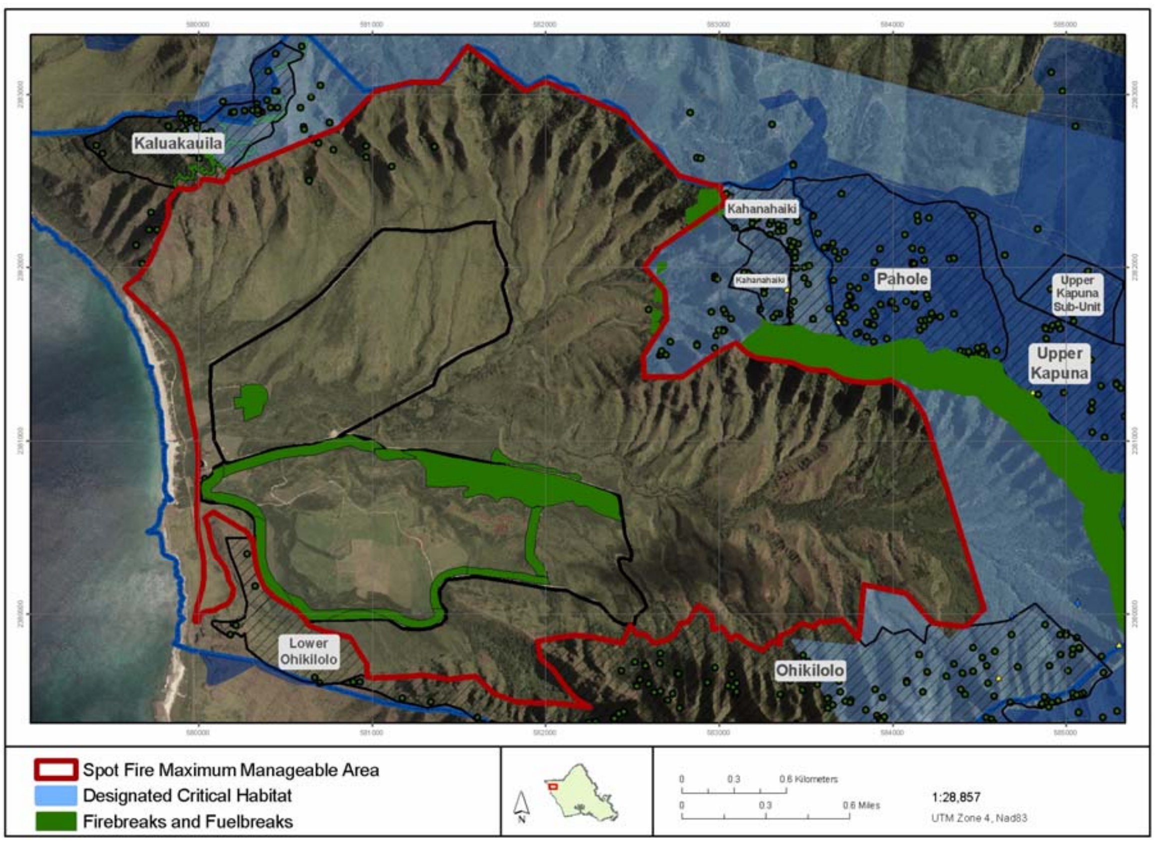


Figure 3: MMA: Prevent fire from burning into Rare Species Management Units, cross-hatched areas and shaded designated critical habitat areas.

There is slightly higher risk associated with burning within the north lobe of the firebreak road because the firebreak is not as wide and slopes are steeper adjacent to the burn unit. There is less risk associated with burning the South Lobe, but some mitigation is necessary because of the close proximity of three endangered plant populations located within the Lower Olikilolo Management Unit (Figure 4). These must be protected from spot fires by fuel treatments or other measures. All standing live and dead grass will be removed from within two meters of all *Hibiscus brackenridegei* ssp. *mokuleianus* and *Chamaesyce celastroides* var. *kaenana* plants growing in the Lower Ohikilolo Management Unit, prior to ignition of a prescribed burn within any area of the prescribed burn unit, or other measures, coordinated with the USFWS, will be in place to ensure that these plants will be adequately protected from a spot fire.

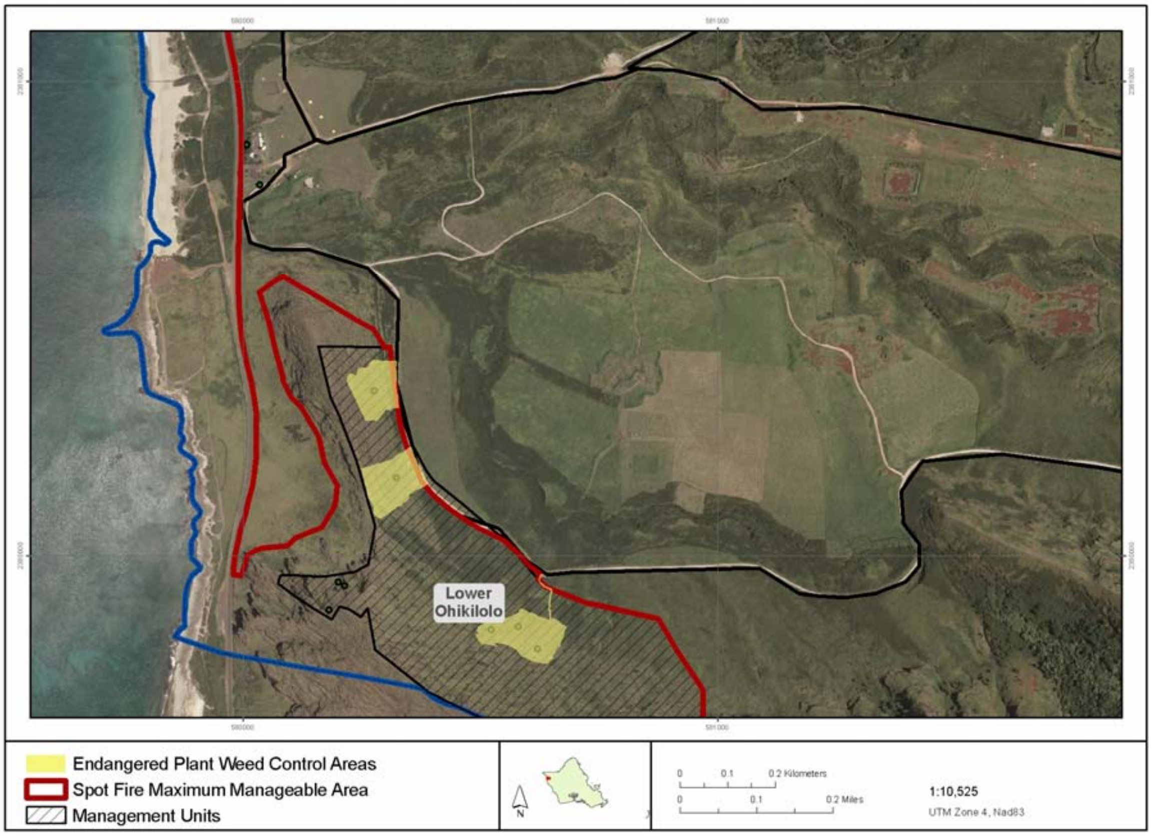


Figure 4: *Chamaesyce herbstii* and *Hibiscus Brackenridgei* subsp. *mokuleianus* occurring within the Lower Ohikilolo Management Unit which will have assigned ground fire resource protection.

No prescribed burning will be done unless all grass is cleared (to less than one percent cover) from within two meters of all individuals of *Chamaesyce herbstii* and *Hibiscus Brackenridgei* subsp. *mokuleianus* occurring within the Lower Ohikilolo Management Unit or other plans, approved by the USFWS are made to ensure that these plants are protected from fire, are implemented. Regardless of progress on grass clearing, resources will be tasked to protect these three areas on the burn day. Equipment that may be used to protect the areas may include heavy brush engines with with hose and personnel capable of reaching the endangered species populations. Because the life of this plan is 30 years, an adaptive management strategy will be employed, to determine the changing needs of the plants. The Army may update this prescribed burn plan at any time and submit it to the Service at any time for review and concurrence that the new plan provides protection to endangered species and critical habitats that is equal to or greater than the protections provided by the current plan. Given the written concurrence of the Service, the updated plan(s) can replace outdated version(s) of the plan.

SECTION 3
GOALS AND OBJECTIVES

A. Purpose of burn

The burn units, historic ranch land, are dominated by the exotic grass, guinea grass (*Panicum maximum)*. This grass grows very tall and dense, creating a fuel complex that is among the heaviest grass fuels documented, comparable in mass to heavy shrub fuels. In order to reduce the intensity of wildfires, and to periodically provide for ground visibility and access to particular sites, prescribed burns are conducted to reduce guinea grass fuel loading and ground cover.

B. Goals

(x) Reduce fuel loading to prevent catastrophic fire
(x) Firefighter and public safety
(x) Protection of endangered species and habit
(x) Fuel break maintenance
(   ) Wildland/urban interface, structure protection
(   ) Ecological restoration or maintenance of critical plant and animal species
(   ) Part of logging/thinning operations
(   ) Hazard fuel reduction away from interface areas and not associated with ecological restoration or silvicultural activities
(x) Protection of archeological or current cultural use sites
(   ) Destruction of exotic species
(   ) Management/restoration of T&E species habitat
(   ) Training burn
(x) Provide vegetation clearance to allow cultural survey and UXO clearance
(   ) Other. Explain:

C. Objectives

<u>Check one or more</u>	**<u>Measure of success</u> (Section 17 records whether objectives were successfully met):**
(**x**) Protect life and property during and after the burn	No one is injured; no private property is damaged, all the burn equipment is accounted for in good condition, after the burn; no damage to archeological sites or other cultural resources.
( ) Reintroduce fire to the ecosystem	"Successful" if burn is completed; "unsuccessful" if burn does not occur
(**x**) Reduce fuel load	Reduce fuel loading by 80-100% to reduce future flame lengths or create or maintain fuel breaks to enable easier suppression of future wildfires.

	Acceptable Final Range (tons)
1 hr fuels	0-2
10 hr fuels	0-2
100 hr fuels	n/a

(**x**) Monitoring	Measurable success would be that the forms attached to the burn plan are completed and properly filed. Collect fire behavior and helicopter productivity data to enable future refinement of prescriptions and fire danger ratings.
(**x**) Smoke management	Manage smoke emissions through best available mitigation measures. Measurable success will be both the lack of complaints and the lack of observed smoke impacting sites to be avoided.

(**x**) Archsite/UXO visibility	Remove 80% or more of ground cover to enhance visibility and expose suspected UXO in particular areas specified.
(**x**) Protect Rare and Endangered Habitat	See map below for areas that must be avoided. Burn will provide future protection to listed species because it will reduce fuels in the vicinity of the firebreak roads.
( ) Other __________________	Indicate a measure of success that can be quantified.

BURN PRESCRIPTION

A. Area to be burned

The area covered by this burn plan is the 322 hectares (796 acres) inside the north and south lobe of the firebreak roads at Makua displayed below. The prescription will be valid for use for a period of 30 years. The burn unit is partitioned by roads. The entire 322 hectare (796 acre) area would not be burned in a single day.

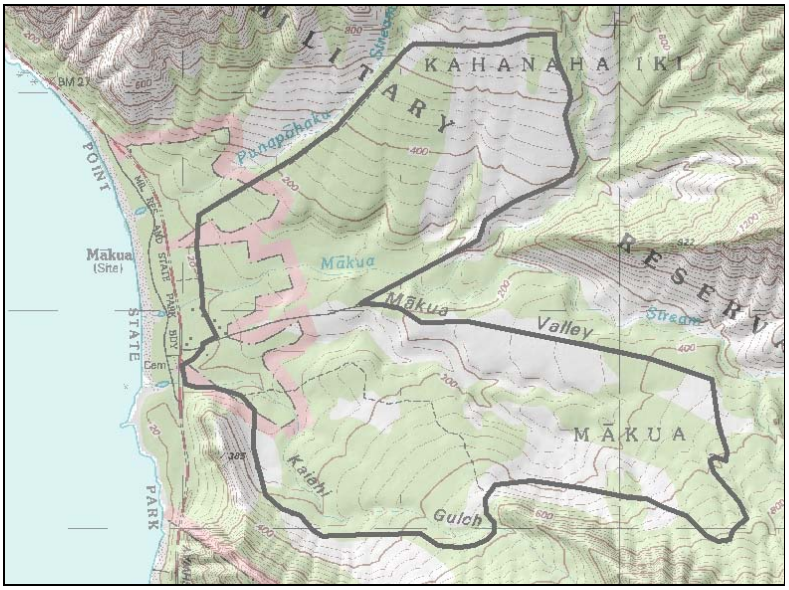


Figure 5: Overall area that will be managed with prescribed burning

B. Schedule

Proposed Ignition Date:	These areas will be burned under this prescription during the lifetime of the Biological Opinion.
Proposed Ignition Duration:	Ignition and active fire spread will be done during periods of optimal fuel moisture and wind conditions, as specified by this plan. If the objectives are not being met or if weather conditions go out of prescription, we will extinguish and postpone the burn. It will take approximately one hour for the helicopters on site to extinguish the burning edge of the fire, partitioning it from the unburned portion of the burn.
Criteria for On-Site Fire Supervisor:	There will be an on-site assigned NWCG –qualified Red Carded RXB2 Burn Boss or an NWCG Red Carded IC Type 4 or Type 5 Qualified Incident Commander responsible for the fire until mop-up operations have extinguished all heat within 60 meters of the firebreak road.
Criteria for declaring the burn out:	There is not a lot of heavy fuel within the burn unit which will hold heat for long periods of time. Any heavy fuel may either be allowed to burn out or it may be mopped

up, possibly with helicopters, to expedite extinguishment of the fire. Because MMR frequently experiences high winds, any burning material, even smoldering fuel in the middle of the burn unit, will be considered at risk of causing a spot fire outside the firebreak road. The burn will only be declared out, or safe to leave, when it is completely out. As a general rule, assurance of a fire being out only occurs after no heat or smokes have been observed in the burned area during windy conditions. The burn will only be declared out by the Army Wildland Fire Management Officer or Assistant Wildland Fire Management Officer. This should eliminate "restart" as a cause of fire at MMR.

C. Desired fire behavior

BehavePlus runs for fuels inside the burn unit and in the contingency areas are summarized for fires burning on a 60 percent slope with upslope winds.

1. The Army is burning live or desiccated guinea grass in the interior of the range and dead and downed fuel along the firebreak road to prepare and maintain the range for training activities. There are therefore no ecological constraints on desired fire behavior within the burn unit.

2. The objectives of the burn include burning combustible fuels inside the firebreak road. In the event a fire does spot, a secondary objective is to burn under fuel and weather conditions in which a spot fire will not be able to reach rare species or critical habitat before being extinguished by the aerial assets available.

3. Any endangered species designated critical habitat burned by a spot fire must be restored pursuant to the specifications in the Biological Opinion.

D. Fuel pre-treatment

The grass and shrub fuels within the target burn area may be treated with herbicide prior to burning in order to facilitate burning when the grass is green. Grass areas inside the burn may be treated with herbicide approximately three weeks prior to the burn date, unless such action will not accomplish the goal of providing dry fuels inside the burn and wet fuels outside the burn. An example of such an exception would be when a burn is scheduled for a time that Guinea grass is already dry enough inside the burn area to accomplish burn objectives. In such a case, there would be no reason to use herbicide.

E. Cumulative effects of drought

Initiating a burn is contingent on an assessment of not only the apparent weather and fuel conditions, but also on the cumulative effects of drought and severe weather conditions. The burn boss will use the following criteria to determine whether drought or severe weather could have an effect on fire behavior:

( ) ERC
( ) KBDI (reference: Pat Costales 973-9787)
( ) Palmer Drought Index
( ) Discussion with professional fire weather forecaster at the following number: _______
(x) Live herbaceous fuel moisture: The burn is limited to a minimum live fuel moisture of 100%, as calculated by WIMS for MMR Range RAWS station (490301). Live herbaceous fuel moisture can be over 250 percent in fresh growth and falls to 30 percent when grass is fully cured. When herbaceous fuel moisture is over 100 percent, it serves as an important heat sink which will slow the rate of spread of a spot fire.

Because this prescribed burn is scheduled for periods when the guinea grass is relatively green, the burn will not be occurring during a drought period.

F. Weather forecasts

A spot weather forecast will be obtained from the National Weather Service for the prescribed fire area. The spot weather forecast will provide, at minimum, the predicted wind speed, relative humidity, and temperature in one hour increments for the entire duration of ignition and any additional periods of active surface fire spread. A fire weather specialist will calculate the forecasted hourly 1-hour fuel moisture conditions for the burn period, utilizing the Fireline Handbook Appendix B. Burning will stop one hour before the spot weather forecast indicates that the burn will be out of prescription and the outer 60 meters of the burning area will be mopped up. If conditions during the burn are not representative of the conditions forecasted, an update to the spot weather forecast will be requested.

G. Capabilities of the resources that are planned to support the burn

Aircraft will be fueled on site, or sufficient aircraft will be on site to cover for helicopters refueling elsewhere. Planning must ensure that there will be sufficient numbers of helicopters on site at all times of various sizes and capabilities to keep an escaped fire from being able to reach rare species habitat. Using the BehavePlus model, the response time of each helicopter is gauged by the time that it would take for the helicopters to respond from a standby position on the ground, and the time it would take the ignition and command/control helicopters to change their missions, exchange equipment, and respond. Refueling time, whether on-site or at Wheeler AAF, is also taken into account in the model.

H. Go-no-go and stop-burning decisions

A go-no-go decision will be made based on a final spot weather forecast issued by NOAA the afternoon before the burn. During the burn, a stop-burning order will be issued if the weather goes out of prescription based on on-site weather observations made by the lookout or designated fire weather/fire behavior officer. Weather observations will be taken every ½ hour and announced over the radio. Weather observations will also be made during wind gust events.

I. Documentation of the burn and fire behavior

The test burn and other events during the burn will be documented by the lookout or designated officer using a video camera.

J. BehavePlus fire behavior computer model

BehavePlus is the national computer model used to calculate predicted fire behavior. The user is able to select from a number of BehavePlus fuel model parameters. The Grass2 Guinea grass fuel model is continually being updated as new fire behavior information becomes available. Army wildland fire management is collaborating with fire behavior researchers from the US Forest Service Pacific Southwest Research Station, the State, and the Center for Environmental Management of Military Lands to gather rate of spread data for headfires burning in mature guinea grass under various live herbaceous fuel moisture, wind, and 1-hour fuel moisture conditions. As new fire behavior data is collected, the Army will work with the Service to develop updated fire suppression helicopter staffing requirements which provide for the containment of fires outside the firebreak road at acreages equal to or smaller than those which would be obtained by the current helicopter staffing requirements, using the current fuel model parameters (Table 1).

Table 1
Live Herbaceous fuel moisture as related to wind adjustment factor and fuel depth in current guinea grass fuel model used in BehavePlus CONTAIN fire behavior simulations.

Live Herbaceous Fuel Moisture (WIMS HRB, Station 490301)	Wind adjustment factor	Fuel bed depth (input into current BehavePlus Guinea grass fuel model)
200+	.5	1.88
150-199	.5	2.4
100-149	.5	2.71
99 and lower	.5	4.11

Fire rate of spread is the most important variable contributing to the ability of helicopters to contain the growing fire. Rate of spread, as predicted by BehavePlus is sensitive to 1-hour timelag dead fuel moisture, which will vary through the day. The burn prescription is written for 1-hour timelag fuel moistures ranging from 7 to 13 and higher (Table 2 below). We are not proposing to conduct prescribed burns when 1-hour fuel moisture is below 7 percent. Wind and live herbaceous fuel moisture make up the balance of the primary variables driving the prescription. The CONTAIN module of BehavePlus was used to determine how many fire suppression helicopters would be assigned to staff the prescribed burn in order to contain spot fires under various prescribed fuel moisture and wind conditions. (Tables 2A, 2B, and 2C below).

I. Weather prescription for the burn

Live herbaceous fuel moisture, wind, and 1-hour fuel moisture are the most important variables affecting ease of control of spot fires. This prescription covers prescribed burning on days when the WIMS-calculated live herbaceous fuel moisture (HRB) at the Makua Range Weather Station # 490301 is 100 percent or greater. Three matrices of acceptable combinations of wind speed and 1-hour fuel moisture were developed for burning at Makua: one for burning under under WIMS-calculated live herbaceous fuel moisture conditions between 100 percent and 119 percent; a second for burning under WIMS-calculated live herbaceous fuel moisture conditions between 120 percent and 149 percent, and a third for burning when WIMS-calcluated live herbaceous fuel moisture is 150 percent or higher (Tables 2 – 4). Fire suppression helicopter staffing requirements are specified for each combination of live herbaceous fuel moisture, wind, and 1-hour fuel moisture condition.

BEHAVE runs predict the rate of spread, and the minute-by-minute perimeter of a spot fire starting under various levels of wind below 15 mph and various 1 hour timelag fuel moistures. Tables 2A and 2B provide the amount of fireline, expressed in chains (1 chain=66 feet), that must be produced by ground or aerial resources to stop a fire. Since UXO prohibit use of ground resources on spot fires outside the firebreak road, the tables show how many chains of fireline helicopters must be able to extinguish under each set of 1 hour fuel moisture and wind speed.

Table 2A. Chains/hour fireline production required of helicopters, on site and on call when live herbaceous fuel moisture calculated by Makua Range WIMS weather station # 490301 is 100% or greater.

10 Minute Average 20 Foot Wind Speed (mph) (Makua Range Weather Station #490301) in both Spot Weather Forecast and hourly observed weather for all periods necessary to complete all active burning and mopup of outer 20 meters, Wind Direction: Any	Fire Suppression Helicopter Staffing Requirements(*1): Minimum Fire Suppression Capability (*2) of Fire Suppression Helicopters Assigned for Water Drops During Prescribed Burns at Makua When Live Herbaceous Fuel Moisture calculated in WIMS (Station 490301) is 100 percent or higher (*3)					
	1 Hour Fuel Moisture (%)					
	8%	9%	10%	11%	12%	13% and higher
0 mph	37 chains/hr (19 on-site / 18 1hr standby)	36 chains/hr (18 on-site / 18 1hr standby)	35 chains/hr (18 on-site / 17 1hr standby)	34 chains/hr (17 on-site / 17 1hr standby)	33 chains/hr (17 on-site / 16 1hr standby)	33 chains/hr (17 on-site / 16 1hr standby)
1 mph	42 chains/hr (21 on-site / 21 1hr standby)	40 chains/hr (20 on-site / 20 1hr standby)	39 chains/hr (20 on-site / 19 1hr standby)	38 chains/hr 19 on-site / 19 1hr standby)	38 chains/hr (19 on-site / 19 1hr standby)	37 chains/hr (19 on-site / 18 1hr standby)
2 mph	47 chains/hr (24 on-site, 23 1hr standby)	45 chains/hr (23 on-site / 22 1hr standby)	44 chains/hr (22 on-site/ 22 1hr standby)	43 chains/hr (22 on-site / 21 1hr standby)	42 chains/ hr (21 on-site / 21 1hr standby)	41 chains/hr (21 on-site / 20 1hr standby)
3 mph	52 chains/hr (26 on-site / 26 1hr standby)	51 chains/hr 26 on-site / 25 1hr standby)	49 chains/hr (25 on-site / 24 1hr standby)	48 chains/hr (24 on-site / 24 1hr standby)	47 chains/hr (24 on-site / 24 1hr standby)	46 chains/hr (23 on-site / 23 1hr standby)
4 mph	57 chains/hr (29 on-site / 28 1hr standby)	56 chains/hr (28 on-site / 28 1hr standby)	54 chains/hr (27 on-site / 27 1hr standby)	53 chains/hr (27 on-site / 26 1hr standby)	52 chains/hr (26 on-site / 26 1hr standby)	51 chains/hr (26 on-site / 25 1hr standby)
5 mph	62 chains/hr (31 on-site / 31 1hr standby)	61 chains/hr (31 on-site / 30 1hr standby)	60 chains/hr (30 on-site / 30 1hr standby)	58 chains/hr (29 on-site / 29 1hr standby)	57 chains/hr (29 on-site / 28 1hr standby)	56 chains/hr (28 on-site / 28 1hr standby)
6 mph	69 chains/hr (35 on-site / 34 1hr standby)	67 chains/hr (34 on-site / 33 1hr standby)	65 chains/hr (33 on-site / 32 1hr standby)	63 chains/hr (32 on-site / 31 1hr standby)	62 chains/hr (31 on-site / 31 1hr standby)	61 chains/hr (31 on-site / 30 1hr standby)
7 mph	74 chains/hr (37 on-site / 37: 1hr standby)	72 chains/hr (36 on-site / 36 1hr standby)	70 chains/hr (35 on-site / 35 1hr standby)	69 chains/hr (35 on-site / 34 1hr standby)	67 chains/hr (34 on-site / 33 1hr standby)	66 chains/hr (33 on-site / 33 1hr standby)
8 mph	80 chains/hr (40 on-site / 40: 1hr standby)	78 chains/hr (39 on-site / 39 1hr standby)	76 chains/hr (38 on-site / 38 1hr standby)	74 chains/hr (37 on-site / 37 1hr standby)	72 chains/hr 36 on-site / 36 1hr standby)	71 chains/hr (36 on-site / 35 1hr standby)
9 mph	86 chains/hr (43 on-site / 43: 1hr standby)	84 chains/hour (42 on-site / 42: 1hr standby)	81 chains/hr (41 on-site / 40 1hr standby)	79 chains/hr (40 on-site / 39 1hr standby)	78 chains/hr (39 on-site / 39 1hr standby)	76 chains/hr (38 on-site / 38 1hr standby)
10 mph		90 chains/hour (45 on-site / 45: 1hr standby)	87 chains/hr (44 on-site / 44: 1hr standby)	85 chains/hr (43 on-site / 42: 1hr standby)	83 chains/hr (42 on-site / 41 1hr standby)	81 chains/hr (41 on-site / 40 1hr standby)
11 mph				91 chains/hr (46 on-site / 45: 1hr standby)	88 chains/hr (44 on-site / 44: 1hr standby)	87 chains/hr (44 on-site / 43: 1hr standby)
12 mph						92 chains/hr (46 on-site / 46: 1hr standby)
13 mph						97 chains/hr (49 on-site / 48: 1hr standby)

(*1) On-site helicopters will have buckets attached and tested so that their first full load of water is dropped on the fire's perimeter within 15 minutes of a spot fire's ignition. Standby helicopter response time will be one hour. Blacked out combinations of 1-hr fuel moisture and wind are out of prescription.

(*2) Fire suppression capability, or fireline construction rate of all fire suppression helicopters is rated in chains/hour. Chains/hour indicates the continuous helicopter fireline construction rate in dense, long-unburned guinea grass at Makua and is a function of turnaround time, length of fire perimeter each water drop extinguishes, and percent of time that is unproductive due to refueling. Refer to Helicopter Productivity Table or individual pilot qualifications card for helicopter productivity rates. Additional aircraft may be assigned to Makua for other purposes including air attack and military operations.

(*3) Fire suppression helicopter staffing requirements may be updated in the future as more research is conducted on the guinea grass fuel model. Acreage of spot fires, as predicted by BehavePlus/CONTAIN would be equal to or less than acreages predicted using the current fuel model parameters and helicopter staffing. No changes to helicopter staffing requirements would be made without the written approval of the USFWS.

Head Fire Rate of Spread, 60% slope: 25 - 69 chains/hour in guinea grass,
Head Fire Flame Length, 60% slope: 4 - 21 feet

Table 2B. Chains/hour fireline production required of helicopters, on site and on call when live herbaceous fuel moisture calculated by Makua Range WIMS weather station # 490301 is 120% or greater.

10 Minute Average 20 Foot Wind Speed (mph) (Makua Range Weather Station #490301) in both Spot Weather Forecast and for all hourly observed weather, for all periods necessary to complete all active burning and mopup of outer 20 meters, Wind Direction: Any	Fire Suppression Helicopter Staffing Requirements(*1): Minimum Fire Suppression Capability (*2) of Fire Suppression Helicopters Assigned for Water Drops During Prescribed Burns at Makua When Live Herbaceous Fuel Moisture calculated in WIMS (Station 490301) is 120 percent or higher (*3)				
	1 Hour Fuel Moisture (%)				
	8%	9%	10%	11%	12% or higher
0-5 mph	48 chains/hr (24 on-site / 24 1hr standby)	47 chains/hr (24 on-site / 23 1hr standby)	46 chains/hr (23 on-site / 23 1hr standby)	45 chains/hr (23 on-site / 22 1hr standby)	44 chains/hr (22 on-site / 22 1hr standby)
6 mph	53 chains/hr (27 on-site / 26 1hr standby)	52 chains/hr (26 on-site / 26 1hr standby)	50 chains/hr (25 on-site / 25 1hr standby)	49 chains/hr (25 on-site / 24 1hr standby)	48 chains/hr (24 on-site / 24 1hr standby)
7 mph	58 chains/hr (29 on-site / 29 1hr standby)	56 chains/hr (28 on-site / 28 1hr standby)	55 chains/hr (28 on-site / 27 1hr standby)	54 chains/hr (27 on-site / 27 1hr standby)	53 chains/hr (27 on-site / 26 1hr standby)
8 mph	63 chains/hr (32 on-site / 31 1hr standby)	61 chains/hr (31 on-site / 30 1hr standby)	60 chains/hr (30 on-site / 30 1hr standby)	58 chains/hr (29 on-site / 29 1hr standby)	57 chains/hr 29 on-site / 28 1hr standby)
9 mph	68 chains/hr (34 on-site / 34 1hr standby)	66 chains/hour (33 on-site / 33 1hr standby)	64 chains/hr (32 on-site / 32 1hr standby)	63 chains/hr (32 on-site / 31 1hr standby)	61 chains/hr (31 on-site / 30 1hr standby)
10 mph	74 chains/hr (37 on-site / 37: 1hr standby)	71 chains/hour (36 on-site / 35: 1hr standby)	69 chains/hr (35 on-site / 34 1hr standby)	67 chains/hr (34 on-site / 33 1hr standby)	66 chains/hr (33 on-site / 33 1hr standby)
11 mph			74 chains/hour (37 on-site / 37: 1hr standby)	72 chains/hr (36 on-site / 36: 1hr standby)	71 chains/hr (36 on-site / 35 1hr standby)
12 mph				77 chains/hr (39 on-site / 38: 1hr standby)	75 chains/hr (38 on-site / 37: 1hr standby)
13 mph					80 chains/hr (40 on-site / 40: 1hr standby)
14 mph					85 chains/hr (43 on-site / 42: 1hr standby)

(*1) Total Helicopter Staffing Requirements in this table apply to all burns conducted at Makua when live herbaceous fuel moisture is 120 percent and higher. On-site productivity rates in this table refer to burns conducted within the North Lobe of the Firebreak Road. For burns conducted entirely within the south lobe of the firebreak road, when live herbaceous fuel moisture calculated by WIMS for weather station 490301 is 120 percent and greater, a minimum of one helicopter, with a minimum fire suppression productivity rate of 12 chains/hour is required to be on-site at Makua with a minimum of a fifteen minute response time to a spot fire and a minimum of one hour of fuel on board. Standby helicopter response time will be one hour. Blacked out combinations of 1-hr fuel moisture and wind are out of prescription.

(*2) Fire suppression capability, or fireline construction rate of all fire suppression helicopters is rated in chains/hour. Chains/hour indicates the continuous helicopter fireline construction rate in dense, long-unburned guinea grass at Makua and is a function of turnaround time, length of fire perimeter each water drop extinguishes, and percent of time that is unproductive due to refueling. Refer to Helicopter Productivity Table or individual pilot qualifications card for helicopter productivity rates. Additional aircraft may be assigned to Makua for other purposes including air attack and military operations.

(*3) Fire suppression helicopter staffing requirements may be updated in the future as more research is conducted on the guinea grass fuel model. Acreage of spot fires, as predicted by Behave/Contain would be equal to or less than acreages predicted using the current fuel model parameters and helicopter staffing. No changes to helicopter staffing requirements would be made without the written approval of the USFWS.

Table 2C. Chains/hour fireline production required of helicopters, on site and on call when live herbaceous fuel moisture calculated by Makua Range WIMS weather station # 490301 is 120% or greater.

10 Minute Average 20 Foot Wind Speed (mph) (Makua Range Weather Station #490301) in both Spot Weather Forecast and observed hourly observations for all periods necessary to complete all active burning and mopup of outer 20 meters, Wind Direction: Any	Fire Suppression Helicopter Staffing Requirements(*1): Minimum Fire Suppression Capability (*2) of Fire Suppression Helicopters Assigned for Water Drops During Prescribed Burns at Makua When Live Herbaceous Fuel Moisture calculated in WIMS (Station 490301) is 150 percent or higher (*3)		
	1 Hour Fuel Moisture (%)		
	7%	8%	9% and higher
0-5 mph	37 chains/hr (9 on-site / 28: standby)	36 chains/hr (9 on-site / 27: standby)	35 chains/hr (9 on-site / 26: standby)
6 mph	41 chains/hr (10 on-site / 31: standby)	40 chains/hr (10 on-site / 30: standby)	39 chains/hr (10 on-site / 29: standby)
7 mph	44 chains/hr (11 on-site / 33: standby)	43 chains/hr (11 on-site / 32: standby)	42 chains/hr (10 on-site / 32: standby)
8 mph	48 chains/hr (12 on-site / 36: standby)	48 chains/hr (12 on-site / 36: standby)	45 chains/hr (11 on-site / 34: standby)
9 mph	52 chains/hr (13 on-site / 39: standby)	50 chains/hr (13 on-site / 37: standby)	49 chains/hr (12 on-site / 37: standby)
10 mph	55 chains/hr (14 on-site / 41: standby)	54 chains/hr (14 on-site / 40: standby)	52 chains/hr (13 on-site / 39: standby)
11 mph		58 chains/hr (15 on-site / 43: standby)	56 chains/hr (14 on-site / 42: standby)
12 mph		61 chains/hr (15 on-site / 46: standby)	60 chains/hr (15 on-site / 45: standby)
13 mph		65 chains/hr (16 on-site / 49: standby)	63 chains/hr (16 on-site / 47: standby)
14 mph			67 chains/hr (17 on-site / 50: standby)

(*1) Total Helicopter Staffing Requirements in this table apply to all burns conducted at Makua when live herbaceous fuel moisture is 150 percent and higher. On-site productivity rates in this table refer to burns conducted within the North Lobe of the Firebreak Road. For burns conducted entirely within the south lobe of the firebreak road, when live herbaceous fuel moisture calculated by WIMS for weather station 490301 is 150 percent and greater, a minimum of one helicopter, with a minimum fire suppression productivity rate of 12 chains/hour (unless less staffing is required in the table, whichever is lower) is required to be on-site at Makua with a minimum of a fifteen minute response time to a spot fire and a minimum of one hour of fuel on board. Standby helicopter response time will be one hour. Blacked out combinations of 1-hr fuel moisture and wind are out of prescription.

(*2) Fire suppression capability, or fireline construction rate of all fire suppression helicopters is rated in chains/hour. Chains/hour indicates the continuous helicopter fireline construction rate in dense, long-unburned guinea grass at Makua and is a function of turnaround time, length of fire perimeter each water drop extinguishes, and percent of time that is unproductive due to refueling. Refer to Helicopter Productivity Table or individual pilot qualifications card for helicopter productivity rates. Additional aircraft may be assigned to Makua for other purposes including air attack and military operations.

(*3) Fire suppression helicopter staffing requirements may be updated in the future as more research is conducted on the guinea grass fuel model. Acreage of spot fires, as predicted by Behave/Contain would be equal to or less than acreages predicted using the current fuel model parameters and helicopter staffing. No changes to helicopter staffing requirements would be made without the written approval of the USFWS.

Head Fire Rate of Spread, 60% slope: 9 - 32 chains/hour
Head Fire Flame Length, 60% slope: 4 - 14 feet

Other Prescribed Fire Weather, Fire Danger, and Fuel Moisture Parameters:

1-hour fuel moisture: Acceptable 1-hour fuel moisture and wind speed combinations have assigned fire suppression helicopter staffing assignments shown in white and grey shaded boxes in Tables 2A and 2B. Blacked out combinations of 1-hour fuel moisture and wind in these tables are not in prescription. Beavers (2001) and Scott and Burgan (2005) estimate that the moisture of extinction for guinea grass is 30 to 40 percent. Maximum prescribed 1-hour fuel moisture is 40 percent.
10-hour fuel moisture: 8 to 30 percent.
Wind Speed: Acceptable 1-hour fuel moisture and wind speed combinations have assigned fire suppression helicopter staffing assignments shown in white and grey shaded boxes in Tables 2A and 2B. Blacked out combinations of 1-hour fuel moisture and wind in these tables are not in prescription.
Wind Direction: Wind direction is not constrained. All midflame, 20-foot, and transport wind directions are in prescription.
Mixing Height: Mixing height is not constrained. All mixing heights are in prescription.
Temperature: 40 degrees F to 100 degrees F.
Relative Humidity: Relative humidity is not a primary prescription parameter. But it is the primary factor driving the prescription parameter 1-hr fuel moisture. When a spot weather forecast is obtained, the Fireline Handbook, Appendix B, Table 2 through 5 will be used to calculate each hour's predicted 1-hr fuel moisture. Aspect South, will always be used for 1-hr fuel moisture forecasting using the Fireline Handbook method. Relative Humidity values between 40 percent and 100 percent MAY produce 1-hr fuel moistures which are in prescription, depending on the temperature, time of day, month, and forecasted cloud cover. The National Weather Service may be capable of providing F-type observations in WIMS, so that 1-hr fuel moisture forecast values could be automatically calculated. Relative humidity of 40 percent would be out of prescription if calculated 1-hour fuel moisture is out of prescription.

Live Herbaceous Fuel Moisture: 100 percent or higher, as calculated by WIMS for Makua Range WIMS weather station number 490301.
Live Woody Fuel Moisture: Not constrained.
Burning Index: Burning Index is not constrained. Burning is permitted when fire danger is high (Red).

J. Helicopter Support Requirements

1. Sufficient helicopters must be present to extinguish the amount of fireline displayed in Tables 2A, 2B, and 2C (see Helicopter productivity in the discussion below). As the guinea grass fuel model is updated, the helicopter staffing guidelines will be revised concurrently. The Army fire staff will present updated helicopter staffing guidelines to the USFWS for approval prior to use for prescribed burn staffing at Makua.

2. Normally one helicopter will be used for ignition, one for command and control, and sufficient additional helicopters will be available to provide the fireline productivity required in Tables 2A or 2B. All helicopters will cease their ignition or command missions and be used for bucket support if a spot fire occurs outside the firebreak road. The helicopters used for ignition and command may be included in fireline productivity calculations. It was assumed that it would take 15 minutes for them to switch missions.

3. Helicopters will be staffed in accordance with tables 2A, 2B, and 2C. On-site helicopters will have buckets attached and tested so that their first full load of water is dropped on the fire's perimeter within 15 minutes of a spot fire's ignition. Standby helicopter response time will be one hour. Additional call when needed military or civilian helicopters, above and beyond those assigned to duty at Makua, will be available to respond within four hours of being requested, in the event of an escaped prescribed burn.

4. All helicopters will have a minimum of one hour of fuel on board and, if possible, there should be fuel on site at Makua. If on-site fuel is not available, the turn-around time for refueling substantially reduces a helicopter's productivity (Table 5). Currently, fuel trucks are the only source of helicopter fuel at Makua. A permanent fuel tank for helicopter fuel may be installed at Makua. Regardless of whether fueling will be done on-site or back at Wheeler, the on-site assigned fire suppression helicopters standing by during exercises at Makua will maintain enough fuel on board to provide one hour of continuous fire bucket operation in addition to any fuel needed to fly to the refueling site after the first hour of work is done. On-site fire suppression helicopters may fly other burn missions including ignition and reconnaissance, as long as they maintain the minimum onboard fuel necessary to fulfill this 1-hour fire suppression flight time requirement.

K. Fire Suppression Aircraft Productivity

Helicopter and air tanker productivity is not something you can look up in a book, because it is a product many factors – including the fire intensity, size of the helicopter bucket or aircraft internal tank, refueling time, turn-around time from the water source to the fire, and pilot experience. The U.S. Fish and Wildlife Service and the U.S. Army are cooperating in studies to determine the fireline productivity of various types of bucket-carrying helicopters and other aircraft and pilots of varying experience in guinea grass in Hawaii. Current helicopter productivity rates (Table 3) are considered preliminary and conservative. The number of chains per hour outlined in Table 3 represents average chains per hour which can be expected. These estimates shall not be utilized if better data, through practical demonstration, can be obtained and assigned to individual pilots or specific aircraft. Productivity rates will not be assigned to individual pilots or specific aircraft for the purposes of satisfying Makua fire suppression staffing requirements without the approval of the U.S. Fish and Wildlife Service.

Table 3. Productivity of various helicopters and other aircraft.

Day Time Aircraft Productivity Estimates for Fire Suppression at Makua Military Reservation

Aircraft Type	Pilot Type	Water Capacity	Not Fueled at Makua	Fueled at Makua	
			All Pilots and All Wind Conditions	20-foot wind speed 11 mph or higher OR No "F"-Type WIMS forecast for wind speed for all hours of scheduled use OR Pilots not yet approved by Army and Fish and Wildlife Service for Higher Productivity Rates	20-foot wind speed "F"-type WIMS forecast: 10 mph or lower AND Expert Pilots Approved by Army and Fish and Wildlife Service at These Productivity Rates
CL415	Contractor	1,800 gallons	**n.a.**	**57 ch/hr**	**114 ch/hr**
S61N or similar	Contractor	1,000 gallons	**13 ch/hr**	**45 ch/hr**	**90 ch/hr**
S61N or similar	Contractor	800 gallons	**10 ch/hr**	**36 ch/hr**	**72 ch/hr**
CH-47 Chinook	Military / Contractor	2000 gallons	**9 ch/hr**	**35 ch/hr**	**n.a.**
UH-60 Blackhawk	Military	660 gallons	**9 ch/hr**	**30 ch/hr**	**n.a.**
CH-46 Sea Knight	Military	400 gallons	**5 ch/hr**	**18 ch/hr**	**n.a.**
CH-53 Sea Stallion	Military	400 gallons	**5 ch/hr**	**18 ch/hr**	**n.a.**
UH-1H Huey	Contractor	340 gallons	**5 ch/hr**	**16 ch/hr**	**32 ch/hr**
Bell 407	Contractor	210 gallons	**3 ch/hr**	**10 ch/hr**	**20 ch/hr**
Bell 206 Long Ranger	Contractor	200 gallons	**3 ch/hr**	**10 ch/hr**	**20 ch/hr**
Bell Jet Ranger	Contractor	120 gallons	**2 ch/hr**	**6 ch/hr**	**13 ch/hr**
Hughes 500	Contractor	110 gallons	**2 ch/hr**	**6 ch/hr**	**12 ch/hr**

L. Management of the Burn

1. Dip ponds will be filled, at a minimum, to 75 percent of total capacity (the 7 ½ -foot mark) prior to ignition. The retardant tank will be filled and retardant will be recirculated.

2. Rare species sites on Lower Olikilolo will be checked to confirm 2 meter grass clearance around plants.

3. All single resource bosses will receive a daytime site visit to view the endangered species protection areas located on Lower Ohikilolo prior to ignition. Pilots will be shown this area and the critical habitat and management unit areas from the air.

4. Ignition of the burn units will generally commence early in the day, when burning conditions are coolest in order to minimize risk. A test fire will be lit by ground crews at a location representative of the fuel. If fire will carry when lit from the ground, we are assured of a good burn in the interior guinea grass. The test burn will not be ignited prior to one hour before sunrise. Ignition of the burn unit will not occur prior to thirty minutes before sunrise, or whenever the helicopters are able to lift off with their first bucket of water. If night time helicopter fire suppression is authorized, night fire suppression guidelines, which provide for protection equal to that of the day time suppression, will be submitted to the USFWS for approval prior to use.

5. If the burn unit takes longer to complete than expected, or if weather and fuel moisture conditions exceed the limits set in the prescription earlier than predicted, the burn will be cut off immediately using direct attack by helicopters. This strategy helps to ensure that no spot fires will ignite under conditions other than those in the prescription.

6. Until the burn is contained (200 feet mopped up around the perimeter), it will be supervised by an on-site Burn Boss or Incident Commander Type 5 with skills and qualifications commensurate with the complexity of a fire at MMR. Until the burn is declared out, it will be monitored during the day by an on-site Burn Boss or Incident Commander Type 5 with skills and qualifications commensurate with the complexity of a fire at MMR.

SECTION 5
ORGANIZATION AND EQUIPMENT

Army regulations require that all personnel on a prescribed burn meet or exceed National Wildfire Coordinating Group standards for qualifications by 2009. This means that all personnel will hold valid “red cards” showing they are qualified to be in the position assigned. Because the Army is not yet able to field qualified personnel, the Director of Fire and Safety has given a directive allowing persons not qualified by NWCG to fill certain fireline positions prior to 2009.

The Burn Boss and Incident Commander positions will always be filled by an NWCG-qualified, red-carded firefighters. For the protection of firefighters assisting from NWCG-agencies (ie. NPS, USFWS, USFS, BLM, BIA and some State personnel), the burn boss will ensure that these cooperators’ firefighters are supervised entirely by only NWCG-qualified personnel within their chain of command. Army personnel who are not yet Engine Boss qualified, would not supervise lesser qualified personnel from NWCG agencies (ie. NPS, USFWS, USFS, BLM, BIA and some State personnel).

Federal standards permit the Army to acknowledge the standards and qualifications of cooperators as determined by those cooperators, including Navy, volunteer fire departments, Honolulu Fire Department, and The Nature Conservancy.

Staffing requirements are indicated in the table below and in the organization chart on the next page. The names of individuals filling those positions will be determined and put on the Incident Action Plan, which is attached to specific burn plans.

Table 4. Minimum personnel required during the ignition, mop-up and patrol phases of the project (these personnel can not fill collateral duty positions)

Position	Ignition Phase	Mop-Up Phase	Patrol Phase
Prescribed Fire Administrator	1[1]		
Prescribed Fire Manager	1[1]		
RxB2 or RxB1 (must be NWCG qualified)[2]	1		
ICT4		1 (or RXB2)	1 (or RXB2)
Ground Safety Officer[3]	1		
UXO Safety Officer	1		
Aircraft Safety Officer	1		
Ignition Boss	1[4]		
PLDO (if utilizing PSD)	1		
Fire Weather Monitor	1[5]		
Federal Fire Holding Bosses	1[6]		
Army Engine Bosses	2[7]	2	
Federal Fire Engine Bosses	3[8]		
Federal Fire Engine Crew	3[8]		
Army Engine Crew	4+	3	1
Helicopter Pilots	Combination of helicopters to meet productivity in ch/hr		

[1] Required only if more than one burn is occurring at one time, including ignition of a new burn when another burn has not been declared out. (The north and south lobe of the firebreak roads at Makua would never be burned on the same day.)

[2] NWCG Red-Carded RxB2 required for Moderate Complexity burns, including South Lobe burns. RxB1 is required for complex burns, as would occur if the North Lobe is burned.

[3] SOF3 or higher is required on High Complexity burns or when one of the three factors of the Safety element of the Complexity Analysis is High, including this burn

[4] RXI2, Ignition Boss qualification is not required for personnel filling Ignition Boss assignments in the Organization Chart
[5] FFT1 or higher with S-290 completed and good communications with national weather service.
[6] Division / Holding Boss positions do not need to be filled by DIVS or Holding Boss-qualified personnel. Beginning on January 1, 2009, the minimum qualification required for personnel in this position on the organization chart will be NWCG-qualified Engine Boss (ENGB). Prior to 2009, the position may be filled by a Firefighter Type 1 with local engine experience.
[7] Beginning on January 1, 2009, the minimum qualification required for personnel in this position on the organization chart will be NWCG-qualified Engine Boss (ENGB). Prior to 2009, the position may be filled by a Firefighter Type 1 with local engine experience.
[7] Engines from cooperating agencies may never meet NWCG requirements.

B. Equipment required during the ignition, mop-up and patrol phases of the project. Minimum and maximum number permitted with this prescribed burn plan are indicated. If the minimum numbers of equipment are not available on day of burn, the burn will be postponed.

Table 5. Minimum equipment required during the ignition, mop-up and patrol phases of the project

Equipment	Ignition Phase	Mop-Up Phase	Patrol Phase
T6 engines (150-400 gal)	5	2	1
T4 engines (750+ gallons, 50 gpm)	1	0	
T3 engines (500+ gallons, 150 gpm)			
Tenders/tankers	2	1	
T1 Helicopter (700 gallons)	worksheet attached indicating helicopters meet ch/hr		
T2 helicopter (300 gallons)	worksheet attached indicating helicopters meet ch/hr		
T3 Helicopter (100 gallons)	worksheet attached indicating helicopters meet ch/hr		
ATV	0-2		

Table 6
Minimum helicopters required during the ignition phase of the project

Live Herbaceous Fuel Moisture %, Calculated for Makua Range Weather Station (WIMS 490301)	**____________________%**
Using Table 2A, 2B, or 2C (Circle one)	**Using: Table 2A Table 2B Table 2C**
Total Helicopter Productivity Required (Chains/Hour) from Tables 2A, 2B, or 2C	**__________Total chains/hour**

Tail #	Pilot Name, Phone #	Fuel on site?	Helo. Productivity
On-site:		Yes / No	_______chains/hr
On-site:		Yes / No	_______chains/hr
On-site:		Yes / No	_______chains/hr
On-site:		Yes / No	_______chains/hr
Subtotal: On-site chains/hour (must be at least 1/2 of total required):			_________
On Call:		Yes / No	_______chains/hr
On Call:		Yes / No	_______chains/hr
On Call:		Yes / No	_______chains/hr
Subtotal: standby helicopter productivity (chains/hour):			__________
Total helicopter productivity assigned (On-site + Standby):			**_______chains/hr**

SECTION 6
COMPLEXITY ANALYSIS

Two complexity analyses were completed below because burning the North Loop of the firebreak road is more complex than burning the South Loop. Refer to the appropriate Complexity Analysis when writing a specific plan for either of these areas.

SECTION 6A
COMPLEXITY ANALYSIS FOR SOUTH LOBE OF FIREBREAK ROAD

This burn was rated for complexity using the worksheets attached. Exceptions to qualifications requirements below must be approved by the Installation Safety Director.

Type	**Complexity**	**Qualification of Burn Boss**
( ) Type 1	High Complexity	RxB1
(**X**) Type 2	Moderate Complexity	RxB2
( ) Type 3	Low Complexity	RxB2
( ) Type 3	Very Low Complexity (all 42 elements of the Complexity rating are low; no possibility of spread or spotting, only one fuel model involved; no aerial operations, and less than 6 personnel involved)	RxB3

Minimum qualifications determined by prescribed fire complexity are listed below. Exceptions must be approved by the Installation Safety Director.

Position	Type 1 Burn	**Type 2 Burn**	Type 3 Burn
Agency Administrator	Required	**Required**	Required
Safety Officer (T1,2,or 3)	Recommended	Optional	Optional
RxM1	Optional	Optional	Optional
RxM2	Not allowed	Optional	Optional
RxB1	Required	Optional	Optional
RxB2	Not allowed	**Required**	Optional
RxB3	Not allowed	Not allowed	Required
RxI1	Required	Optional	Not applicable
RxI2	Not allowed	Optional	Not applicable

Holding specialist: Holding functions will be managed by personnel qualified at the appropriate ICS wildland fire operations position as required by complexity, assigned resources and operational span of control. For some projects, there may be no holding requirements or the holding duties are assumed by the Burn Boss.

Prescribed Fire Complexity Rating System Guide Worksheet

Project Name: MMR 06-03 (South Lobe of Firebreak Road)

1. Potential for Escape

Risk	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	All targeted burn areas are inside the lobes of the firebreak road. Measures will be taken to minimize the potential for spot fire occurrence and to minimize spot fire size. Effectiveness of engines and ground personnel is limited to road edges and other areas cleared of UXO. Based on BEHAVE/CONTAIN runs, effective helicopter support will be critical in containing spot fires outside the prescribed burn area.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Koa haole shrubs are particularly prone to causing spot fires and this shrub grows in the burn units, but the probability of a lit firebrand traveling to the maximum spotting distance is low. Historically, spot fires have occurred within several feet of the firebreak road, not any farther upslope. Ninety five percent of all spot fires are expected to occur within 60 meters of the burn perimeter. However, long range spotting may occur. Although maximum spotting distance increases as wind speed increases, the prescribed 1-hour fuel moisture decreases, and subsequently probability of ignition of a spot fire decreases. The maximum spotting distance, give a 14 mph wind, is 805 meters, but burning is only prescribed for high live herbaceous and 1-hour fuel moistures at such high wind speeds. It is unlikely that firebrand will stay ignited 805 meters and land on receptive fuel (as this type of long-range spotting has not previously been observed in guinea grass), but if it does, the probability of ignition of a spot fire at a 1-hour fuel moisture of 12% is 26 percent. Although the probability of ignition of a short-range spot fire remains moderate (at 1-hour fuel moisture of 8%, probability of ignition is 46%), the ignition protocols are conservative and the holding forces are adequate. Because spot fires are possible, helicopter suppression support has been prescribed which will limit the size of any spot fire occurring in guinea grass, on a 60% slope with direct upslope winds to between four and 88 acres. Fire spread is predicted to be much slower, and helicopter suppression is predicted to be much more effective, once the fire spreads into the lighter molasses grass areas, higher on the slope. The Maximum Manageable Area (MMA) does provide for a potential maximum spot fire size of 88 acres. Spot fire size would be limited by 1-hour response time of standby helicopters. As implementation of these plans progresses and fuel breaks become better developed, risk to the Management Units and critical habitats will decrease. The largest spot fire within the forest fuels would be 0.3 acres. Previous prescribed burns conducted within the south lobe of the firebreak road have not escaped.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Federally listed fire-sensitive endangered and threatened plants and animals, and substantial areas of critical habitat are located upslope of the burn unit, outside the main firebreak road.

Final Rating: *Low Moderate **<u>High</u>***	All personnel will be familiar with the locations of critical resources which could be damaged by fire so that suppression actions can be prioritized in order to better ensure that these resources or the shrub vegetation protecting them are protected from fire.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low Moderate **<u>High</u>***	Ignition is scheduled to be completed when all of the spot weather forecast hourly parameters and fuel moisture conditions are predicted to be in prescription during all hours of the burn. Ignition will not commence until early twilight, approximately 30 minutes prior to sunrise, or whenever fire suppression helicopters are available for fire suppression work.
Final Rating: *Low **<u>Moderate</u>** High*	While the use of engines and helicopters ensures the adequacy of holding operations, the presence of UXO will still limit the effectiveness of ground-based resources off the perimeter roads. A skilled weather observer and/or IMET will be necessary in order to monitor all of the current and expected weather and fuel moisture conditions to better ensure that burning conditions remain within prescribed limits during the burn.

2. The Number and Dependency of Activities

Risk	**Rationale**
Preliminary Rating: *Low **<u>Moderate</u>** High*	Coordination and cooperation between various parties on the burn will is complicated by the use of personnel from several agencies and fire suppression organizations. Multiple aircraft will be assigned to the burn.
Final Rating: *Low **<u>Moderate</u>** High*	This will be mitigated by briefings and ensuring that all resources are able to communicate via a common radio frequency. Multiple aircraft increase the complexity of the burn.
Potential Consequences	**Rationale**
Preliminary Rating: *Low Moderate **<u>High</u>***	Failure to communicate can be result in an escaped prescribed burn or a fatality. Coordination and a coordinated and timely response will be necessary to prevent spot fires and ensure inefficient response to spot fires.
Final Rating: *Low Moderate **<u>High</u>***	Briefings will be thorough and will incorporate coordination and communication.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low **<u>Moderate</u>** High*	Continuous coordination and communication is critical to the success of holding and contingency actions.
Final Rating: *Low **<u>Moderate</u>** High*	Multiple aircraft increase the complexity of the burn. Air attack may be necessary. Radio, telephone, and internet communications will be established and maintained.

3. Off-Site Values

Risk	Rationale
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Cultural resources, endangered species critical habitat, and endangered species could be threatened by a spot fire.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	The parameters in this prescription were developed to minimize the risk of loss of off-site values in a spot fire.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	The consequence of damaging critical habitat would be very high if an escape damages habitat. All existing wild individuals of some plant species may be extirpated by a large escaped prescribed burn.
Final Rating: *Low* *Moderate* ***<u>High</u>***	The Army is implementing stabilization plans for the listed species in the Makua area. Even when listed species in the Makua Action Area are stabilized, many "manage for stability" populations will remain in the vicinity of the burn. Loss of individuals in these target populations due to an escaped prescribed burn would be unacceptable. Loss of listed plants growing outside the Management Units, although not preferable, may occur. Furthermore, the implementation of grass removal in the vicinity of listed species, as well as landscape scale conversion of grass areas into firebreaks and shaded fuel breaks will ensure that listed species inside the Management Units and critical habitat areas will not be impacted by a spot fire. Burned designated critical habitat areas or forested areas within the Management Units would be restored pursuant to the specifications in the Biological Opinion.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Steep slopes, flammable exotic grass fuels, unexploded ordinance, and multiple aircraft give suppression of spot fires high technical difficulty.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Technical difficulty of utilization of multiple aircraft to suppress spot fires in heavy grass fuels on steep slopes is high, although our experience suggests that when the grass is green (live herbaceous fuel moisture 100 percent and higher), it may be less difficult. Many factors affecting technical difficulties associated with control of spot fires can not be mitigated, although pre-ignition checks will ensure a high reliability organization operates in the event of a spot fire.

4. On-Site Values

Risk	Rationale
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Fire could threaten certain aspects of archeological and cultural resources within the burn units.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Grass fuels will be cleared back from around all known archeological resources which could be injured by fire prior to burning.

Potential Consequences	Rationale
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Fire could threaten certain aspects of archeological and cultural resources within the burn units.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Grass fuels will be cleared back from around all known archeological resources which could be injured by fire prior to burning.
Technical Difficulty	**Rationale**
Preliminary Rating: ***<u>Low</u>*** *Moderate* *High*	Grass fuels can be cleared by hand crews using weed eaters.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Grass fuels can be cleared by hand crews using weed eaters.

5. Fire Behavior

Risk	Rationale
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Adequate consumption of fuels inside the unit, particularly around the edges and any other area targeted for fuel reduction would require burning under conditions where the potential for a rapidly growing spot fire also exist. Guinea grass burns with approximately three times the flame length as FBPS Fuel Model 3 (tall grass, including sawgrass).
Final Rating: *Low* ***<u>Moderate</u>*** *High*	In order to take advantage of cooler burning conditions when a spot fire's growth would be slowed by fuel moisture conditions, areas specifically targeted for fuel reduction within the burn units may be browned by herbicide treatment prior to burning and the burn will only be conducted when live herbaceous fuel moisture outside the burn unit is calculated to be 100% or higher at the Makua Range weather station (WIMS 490301). To ensure that herbicide does not drift from the targeted areas to any areas outside the burn units, herbicide will only be applied by skilled pilots on days when wind conditions are conducive to application accuracy. The herbicided grass is highly flammable and will burn with high flame lengths and rates of spread, even under cool burning conditions early in the morning. Guinea grass, even with live fuel moistures over 100% and high dead fuel moistures, is still capable of producing flame lengths over 10 feet and high rates of spread so sufficient suppression force will be required to contain spot fires. Burned grass areas remain hot and inaccessible to firefighters long after the fire front has passed.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Spot fires are a substantial concern at Makua. Maximum spotting distance and spot fire size are minimized by burning under light wind conditions.

Final Rating: *Low* ***Moderate*** *High*	Koa howlie shrubs are particularly prone to causing spot fires and this shrub grows in the burn units.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Need to mitigate for potential extreme fire behavior by burning under relatively cool burning conditions. Need to protect listed species from fire by managing grass fuels.
Final Rating: *Low* ***Moderate*** *High*	To better ensure a high reliability organization during the implementation of the prescribed burn, several issues will be dealt with prior to ignition, including hooking up and testing all helicopter water buckets, testing communications, and completing grass control efforts in the vicinity of "manage for stability" populations of listed species in Lower Ohikilolo Management Unit.

6. Management Organization

Risk	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Burn requires substantial coordination with National Weather Service fire desk forecasters, military and civilian contract helicopters, Army fire staff, and other Army and interagency fire personnel.
Final Rating: *Low* ***Moderate*** *High*	Several agencies will participate in the prescribed burn. Highly skilled NWCG – qualified personnel and personnel from other fire agencies with substantial local experience will be assisting with the burn.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Lack of coordination resulting in the lack of a detailed spot weather forecast, poor road maintenance, or the lack of sufficient qualified ignition and holding resources would result in a no-go decision for burning. Poor press coverage would hamper the Army's credibility and future ability to manage the site successfully.
Final Rating: *Low* *Moderate* ***High***	Rescheduling the burn due to a no-go decision may require additional herbicide if previously treated areas have greened up. Poor press coverage can be mitigated by working with Public Information Officer.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Substantial coordination will occur prior to and during the burn to ensure that all necessary activities are coordinated.
Final Rating: *Low* ***Moderate*** *High*	Substantial coordination will occur prior to and during the burn to ensure that all necessary activities are coordinated.

7. Public and Political Interest

Risk	**Rationale**

Preliminary Rating: *Low* *Moderate* ***High***	This area is very controversial, and a burn will be controversial. Escapes have occurred in the past, and were major media events.
Final Rating: *Low* *Moderate* ***High***	Successful, professionally conducted prescribed burns will result in increased trust in the Army's work at Makua. Regardless of the success of prescribed burns, Army activity in Makua valley is likely to remain a concern to many interest groups.

Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Escaped prescribed burns damage cultural, scenic, aesthetic, and natural resources.
Final Rating: *Low* *Moderate* ***High***	Successful, professionally conducted prescribed burns will result in increased trust in the Army's work at Makua. Regardless of the success of prescribed burns, Army activity in Makua valley is likely to remain a concern to many interest groups.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	The Army public relations office can work with the public and media to engender support for the prescribed burn. Prescribed weather and fuel moisture conditions must be substantially limited, and suppression forces must be substantial to ensure that resources are protected.
Final Rating: *Low* *Moderate* ***High***	Public relations and coordination of substantial suppression resources are scheduled to ensure that resources are not damaged by the prescribed burn.

8. Fire Treatment Objectives

Risk	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	The continuous grass fuel burns readily, however, at high live herbaceous fuel moistures, burns have historically been patchy.
Final Rating: *Low* ***Moderate*** *High*	Herbicide may be applied to areas which must burn to ensure complete consumption and to further aid in grass fuel reduction on the site.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	If we miss burning any targeted burn areas, they can be re-treated with herbicide and burned after three to four weeks.
Final Rating: *Low* ***Moderate*** *High*	Because all holding forces would be necessary for the second burn, the second burn would approximately double the cost of the burn. The financial costs associated with this burn are substantial.
Technical Difficulty	**Rationale**

Preliminary Rating: *Low* ***Moderate*** *High*	It is not difficult to identify dried areas from the air or ground, so the target burn areas will be easy to find. Depending on fuel moisture and weather conditions, it may be moderately difficult to burn the unit.
Final Rating: *Low* ***Moderate*** *High*	It is not difficult to identify dried areas from the air or ground, so the target burn areas will be easy to find. Depending on fuel moisture and weather conditions, it may be moderately difficult to burn the unit.

9. Constraints

Risk	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Endangered species stabilization, fuelbreaks and firebreaks, and fire suppression contingency force planning, and burn preparation are expensive and require substantial commitments from Army environmental and fire staffs.
Final Rating: *Low* ***Moderate*** *High*	A spot weather forecast with forecasted weather for each hour during the burn will enable the procurement of the appropriate contingent of air support for suppression of a spot fire to minimize costs. Fuelbreak and firebreak completion will further reduce costs.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	If the objectives are not being met or if weather conditions go out of prescription, we will extinguish and postpone the burn. It will take approximately one hour for the helicopters on site to extinguish the burning edge of the fire, partitioning it from the unburned portion of the burn.
Final Rating: *Low* ***Moderate*** *High*	If the spot weather forecast called for all weather conditions to be in prescription for the duration of the burn and one hour after ignition, and the fire escapes due to an unexpected weather event, the Army does not bear such a burden of blame for the escape.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Funding, spot weather forecast requests, and resource ordering will be moderately difficult to coordinate.
Final Rating: *Low* ***Moderate*** *High*	Funding, spot weather forecast requests, and resource ordering will be moderately difficult to coordinate.

10. Safety

Risk	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Unexploded ordinance (UXO) may detonate when it is burned. Air and ground resources are on different radio frequencies. Herbicided grass may be hazardous to firefighter health.
Final Rating: *Low* *Moderate* ***High***	Firefighters and helicopters must follow standard operating procedures when igniting burn unit and fighting spot fires in order to reduce exposure to unexploded ordinance. Firefighters will be positioned to limit exposure to smoke from herbicided grass.

Potential Consequences	**Rationale**
Preliminary Rating: *Low Moderate* ***<u>High</u>***	The consequences of a UXO detonation could be hearing loss, trauma, or fatality if a firefighter is in the burst radius.
Final Rating: *Low Moderate* ***<u>High</u>***	Briefings will be provided to all resources to ensure understanding of the mitigation measures needed to minimize risk associated with UXO and herbicide.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low Moderate* ***<u>High</u>***	Substantial mitigation measures need to be instituted in order to reduce firefighter exposure to UXO and herbicide smoke.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Standard operating procedures have been developed ahead of time so that all resources can be briefed on limiting exposure to UXO and herbicide smoke. Use of helicopters substantially reduces firefighter exposure to UXO.

11. Ignition Procedures/Methods

Risk	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Technical expertise has been specified by the plan in order to control ignition sequence in order to prevent spot fires. The burn will be cut off when weather parameters hit prescribed limits to ensure that no spot fire is ignited under other than the prescribed conditions. In order to reduce the chance of fire spread if weather parameters go out of prescription, the interior of any large expanses within the burn unit will be ignited to keep it relatively even with the edges. This may require the use of flare guns or aerial ignition in the interior of the burn units.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	If grass is treated with herbicide it will not be difficult to black line by hand. No ignition of the burn area perimeter will be conducted from the air unless there is an area 60 meters or wider between the burn area and the firebreak road which is either mowed grass with live herbaceous fuel moisture content over 200% or otherwise treated vegetation that is not likely to burn. Aerial ignition will not be conducted immediately adjacent to any perimeter firebreak road until the firebreak road has been blacklined by hand.
Potential Consequences	**Rationale**
Preliminary Rating: *Low Moderate* ***<u>High</u>***	The results of a mistake in ignition could be a spot fire and a threat to endangered species.
Final Rating: *Low Moderate* ***<u>High</u>***	The results of a mistake in ignition may be a spot fire and a threat to endangered species.
Technical Difficulty	**Rationale**

Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Firefighters skilled in ignition and holding will be needed to conduct blacklining along the perimeter of the unit.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Preparation of the perimeter of the unit with herbicide will reduce the difficulty the ignition crew will have with blacklining operations. Aerial ignition will be conducted by a highly skilled pilot with many years of aerial ignition experience in Guinea grass fuels. Because holding will rely heavily on the use of helicopter bucket operations, the technical difficulty of ignition remains moderate.

12. Interagency Coordination

Risk	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Several agencies will be contributing skilled personnel to the burn. The Army is in a period of building trust with other agencies and the public following recent escaped prescribed burns at Makua.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Skilled personnel from many agencies will assist with planning and implementation of the burn. If the burn escapes and the Army used this best available weather data and drew on the best available expertise, the Army would limit their exposure to law suits.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Disagreement between the agencies, or finger pointing in after-actions of an escape are very damaging to agency cooperation. However, assistance from available skilled specialists from other agencies in Hawaii, including experts from the National Weather Service, National Park Service, US Forest Service, and the US Fish and Wildlife Service and using skilled ignition and holding personnel from other agencies could increase the likelihood of a successful outcome to the burn.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Skilled personnel from many agencies will assist with planning and implementation of the burn. If the burn escapes and the Army used this best available weather data and drew on the best available expertise, the Army would limit their exposure to law suits.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Army staff must maintain cooperative agreements and have protocols in place for ordering resources to fill prescribed fire positions.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	The Army has protocols in place for ordering Army and civilian contract helicopter support, and assistance from Navy Fed Fire Depatrment, PTA firefighters from the Big Island. The National Weather Service has developed a new internet-based spot weather forecast for prescribed burns. Given updated cooperative agreements, US Department of Interior and Agriculture personnel could be available, free of charge, to the Army to fill skilled positions on the prescribed burn.

13. Project Logistics

Risk	Rationale
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Many logistical tasks must be completed ahead of time to ensure that all needed supplies and equipment are on site for the burn. Helicopter fuel must be on site during the burn. No food or overnight accommodations other than tents are available at Makua.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Planning and pre-positioning will ensure that logistical needs will be satisfied.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	If any required item is missing, we would need to postpone the burn.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	If any required supplies are missing, we will postpone the burn.
Technical Difficulty	**Rationale**
Preliminary Rating: ***<u>Low</u>*** *Moderate* *High*	Planning will mitigate this factor.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Planning will mitigate this factor. Many logistical tasks will be completed ahead of time to ensure that all supplies and equipment are on site for the burn.

14. Smoke Management

Risk	Rationale
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Paved public road leading to relatively low use beaches adjacent to Makua may be crowded with onlookers. Need to monitor smoke on public road and post speed limits according to visibility. Accidents may occur which are unrelated to prescribed burn's smoke so smoke and visibility monitoring will be necessary to ensure the smoke does not contribute to an accident. Set up temporary prescribed burn signs on public road. Smoke may cause the greatest concern just before sunrise when smoke dispersion and visibility in general is still poor. However, very little traffic is expected in the Makua area so early in the morning. Good daytime dispersion will minimize smoke on road. Residual smoke will be limited due to rapid consumption of grass fuels.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Smoke conditions on Farrington Highway will be monitored and traffic will be controlled if necessary if visibility becomes a concern.
Potential Consequences	**Rationale**

Preliminary Rating: ***Low*** *Moderate* *High*	An accident on the public paved road resulting in injury or private property damage could be blamed on a smoke-related visibility issue. Need to monitor and document smoke and visibility on the highway during the prescribed burn. Need to institute nationally recognized smoke management plan for setting speed limits, controlling traffic with escorts, and closing the road.
Final Rating: ***Low*** *Moderate* *High*	Visibility will be monitored and documented on the public paved road during the prescribed burn per the smoke management section of the plan. Traffic controls, including speed limit restrictions, escorts, and road closure will be applied according to the smoke management section of the plan.
Technical Difficulty	**Rationale**
Preliminary Rating: ***Low*** *Moderate* *High*	Will need to check weather forecasts and get a spot weather forecast and be vigilant. Smoke from dried vegetation will be minimal.
Final Rating: ***Low*** *Moderate* *High*	Smoke conditions on Farrington Highway will be monitored and traffic will be controlled if necessary if visibility becomes a concern.

ANALYSIS OF OVERALL COMPLEXITY

Hazard Element	Complexity Value		
	L	M	H
1. Potential for escape		x	
2. Number and dependency of activities		x	
3. Off-site values		x	
4. On-site values	x		
5. Fire behavior		x	
6. Management organization		x	
7. Public and political interest			x
8. Fire treatment objectives		x	
9. Constraints		x	
10. Safety			x
11. Ignition procedures/methods		x	
12. Interagency coordination		x	
13. Project logistics		x	
14. Smoke management	x		
Total	**2**	**10**	**2**
Resulting Determination	**MODERATE**		

SUMMARY COMPLEXITY RATING

Risk, Consequences and Difficulty	L	M	H
Risk	1	11	2
Potential Consequences	2	3	9
Technical Difficulty	3	9	2
Total	6	23	13
Resulting Determination	MODERATE		

QUALIFICATIONS DETERMINATION TABLE

	RxB3	RXB2	RXB1
Number of factors rated at Low, Medium and High in the Hazard Complexity Analysis	Extremely low complexity burns	Less than 4 factors are rated "high"	4 or more factors are rated "high" **OR** when deemed appropriate by the agency administrator or unit Fire Management Officer.
Prescribed Fire Burn Boss Level Indicated (check one):		X	

Overall Complexity and Rationale:
Both the tables above indicate an overall complexity of **Moderate.**

Prepared by: ______________________ Date: December 11, 2006
Jason Greenlee, RxB2

Approved by: ______________________ Date: ____________
(Agency Administrator)

SECTION 6B
COMPLEXITY ANALYSIS FOR NORTH LOBE FIREBREAK ROAD

This burn was rated for complexity using the worksheets attached. Exceptions to qualifications requirements below must be approved by the Installation Safety Director.

Type	Complexity	Qualification of Burn Boss
(**X**) Type 1	High Complexity	RxB1
( ) Type 2	Moderate Complexity	RxB2
( ) Type 3	Low Complexity	RxB2
( ) Type 3	Very Low Complexity (all 42 elements of the Complexity rating are low; no possibility of spread or spotting, only one fuel model involved; no aerial operations, and less than 6 personnel involved)	RxB3

Minimum qualifications determined by prescribed fire complexity are listed below. Exceptions must be approved by the Installation Safety Director.

Position	**Type 1 Burn**	Type 2 Burn	Type 3 Burn
Agency Administrator	**Required**	Required	Required
Safety Officer (T1,2,or 3)	Recommended	Optional	Optional
RxM1	Optional	Optional	Optional
RxM2	Not allowed	Optional	Optional
RxB1	**Required**	Optional	Optional
RxB2	Not allowed	Required	Optional
RxB3	Not allowed	Not allowed	Required
RxI1	**Required**	Optional	Not applicable
RxI2	Not allowed	Optional	Not applicable

Holding specialist: Holding functions will be managed by personnel qualified at the appropriate ICS wildland fire operations position as required by complexity, assigned resources and operational span of control. For some projects, there may be no holding requirements or the holding duties are assumed by the Burn Boss.

Prescribed Fire Complexity Rating System Guide Worksheet
Project Name: MMR 06-03 (North Lobe of Firebreak Road)

1. Potential for Escape

Risk	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	All targeted burn areas are inside the lobes of the firebreak road. Given a 10 mph wind, spot fires could ignite as far as 500 meters from the burn unit, on the outside of the main firebreak road. Effectiveness of engines and ground personnel is limited to road edges and other areas cleared of UXO. Based on BEHAVE/CONTAIN runs, effective helicopter support will be critical in containing spot fires outside the prescribed burn area.
Final Rating: *Low* ***Moderate*** *High*	Koa haole shrubs are particularly prone to causing spot fires and this shrub grows in the burn units, but the probability of a lit firebrand traveling to the maximum spotting distance is low. Historically, spot fires have occurred within several feet of the firebreak road, not any farther upslope. Ninety five percent of all spot fires are expected to occur within 60 meters of the burn perimeter. However, long range spotting may occur. Although maximum spotting distance increases as wind speed increases, the prescribed 1-hour fuel moisture decreases, and subsequently probability of ignition of a spot fire decreases. The maximum spotting distance, give a 14 mph wind, is 805 meters, but burning is only prescribed for high live herbaceous and 1-hour fuel moistures at such high wind speeds. It is unlikely that firebrand will stay ignited 805 meters and land on receptive fuel, but if it does, the probability of ignition of a spot fire at a 1-hour fuel moisture of 12% is 26 percent. Because spot fires are possible, helicopter suppression support has been prescribed which will limit the size of any spot fire occurring in guinea grass, on a 60% slope with direct upslope winds to between four and 88 acres. The largest spot fire within the forest fuels would be 0.3 acres. The Maximum Manageable Area (MMA) does provide for a potential maximum spot fire size of 88 acres. Although the probability of ignition of a short-range spot fire remains moderate (at 1-hour fuel moisture of 7%, probability of ignition is 53%), the ignition protocols are conservative and the holding forces are adequate. There is approximately a 90 percent greater probability of spot fire occurrence on prescribed burns in the north lobe of the firebreak road, than on burns in the south lobe of the firebreak road, due to the lack of grass mowing/treatment along the inside edge of the firebreak road in the north lobe. Suppression forces are adequate to contain all spot fires occurring during the burn, and escape is not anticipated.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Federally listed fire-sensitive endangered and threatened plants and animals, and substantial areas of critical habitat are located upslope of the burn unit, outside the main firebreak road.
Final Rating: *Low* *Moderate* ***High***	All personnel will be familiar with the locations of critical resources which could be damaged by fire so that suppression actions can be prioritized in order to better ensure that these resources or the shrub vegetation protecting them are protected from fire.
Technical Difficulty	**Rationale**

Preliminary Rating: *Low* *Moderate* ***High***	Ignition is scheduled to be completed when all of the spot weather forecast hourly parameters and fuel moisture conditions are predicted to be in prescription during all hours of the burn. Ignition will not commence until early twilight, approximately 30 minutes prior to sunrise, or whenever fire suppression helicopters are available to commence fire suppression work.
Final Rating: *Low* *Moderate* ***High***	While the use of engines and helicopters ensures the adequacy of holding operations, the presence of UXO will still limit the effectiveness of ground-based resources off the perimeter roads. A skilled weather observer and/or IMET will be necessary in order to monitor all of the current and expected weather and fuel moisture conditions to better ensure that burning conditions remain within prescribed limits during the burn. This is a relatively large burn unit with relatively narrow perimeter lines. Endangered species occur immediately adjacent and upslope of the burn unit.

2. The Number and Dependency of Activities

Risk	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Coordination and cooperation between various parties on the burn will is complicated by the use of personnel from several agencies and fire suppression organizations. Multiple aircraft will be assigned to the burn.
Final Rating: *Low* ***Moderate*** *High*	This will be mitigated by briefings and ensuring that all resources are able to communicate via a common radio frequency. Multiple aircraft increase the complexity of the burn.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Failure to communicate can be result in an escaped prescribed burn or a fatality. Coordination and a coordinated and timely response will be necessary to prevent spot fires and ensure inefficient response to spot fires.
Final Rating: *Low* *Moderate* ***High***	Briefings will be thorough and will incorporate coordination and communication.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Continuous coordination and communication is critical to the success of holding and contingency actions.
Final Rating: *Low* ***Moderate*** *High*	Multiple aircraft increase the complexity of the burn. Air attack may be necessary. Radio, telephone, and internet communications will be established and maintained.

3. Off-Site Values

Risk	**Rationale**

Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Cultural resources, endangered species critical habitat, and endangered species could be threatened by a spot fire.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	The parameters in this prescription were developed to minimize the risk of loss of off-site values in a spot fire.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	The consequence of damaging critical habitat would be very high if an escape damages habitat. All existing wild individuals of some plant species may be extirpated by a large escaped prescribed burn.
Final Rating: *Low* *Moderate* ***<u>High</u>***	The Army is implementing stabilization plans for the listed species in the Makua area. Even when listed species in the Makua Action Area are stabilized, many "manage for stability" populations will remain in the vicinity of the burn. Loss of individuals in these target populations due to an escaped prescribed burn would be unacceptable. Loss of listed plants growing outside the Management Units, although not preferable, may occur. Measures will be taken to minimize the potential for spot fire occurrence and to minimize spot fire size. Furthermore, the implementation of grass removal in the vicinity of listed species, as well as landscape scale conversion of grass areas into firebreaks and shaded fuel breaks will ensure that listed species inside the Management Units and critical habitat areas will not be impacted by a spot fire. Burned designated critical habitat areas or forested areas within the Management Units would be restored pursuant to the specifications in the Biological Opinion.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Steep slopes, flammable exotic grass fuels, unexploded ordinance, and multiple aircraft give suppression of spot fires high technical difficulty.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Technical difficulty of utilization of multiple aircraft to suppress spot fires in heavy grass fuels on steep slopes is high, although our experience suggests that when the grass is green (live herbaceous fuel moisture 100 percent and higher), it may be less difficult. Many factors affecting technical difficulties associated with control of spot fires can not be mitigated, although pre-ignition checks will ensure a high reliability organization operates in the event of a spot fire.

4. On-Site Values

Risk	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Fire could threaten certain aspects of archeological and cultural resources within the burn units.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Grass fuels will be cleared back from around all known archeological resources which could be injured by fire prior to burning.

Potential Consequences	Rationale
Preliminary Rating: *Low* ***Moderate*** *High*	Fire could threaten certain aspects of archeological and cultural resources within the burn units.
Final Rating: ***Low*** *Moderate* *High*	Grass fuels will be cleared back from around all known archeological resources which could be injured by fire prior to burning.
Technical Difficulty	**Rationale**
Preliminary Rating: ***Low*** *Moderate* *High*	Grass fuels can be cleared by hand crews using weed eaters.
Final Rating: ***Low*** *Moderate* *High*	Grass fuels can be cleared by hand crews using weed eaters.

5. Fire Behavior

Risk	Rationale
Preliminary Rating: *Low* *Moderate* ***High***	Adequate consumption of fuels inside the unit, particularly around the edges and any other area targeted for fuel reduction would require burning under conditions where the potential for a rapidly growing spot fire also exist. Guinea grass burns with approximately three times the flame length as FBPS Fuel Model 3 (tall grass, including sawgrass).
Final Rating: *Low* ***Moderate*** *High*	In order to take advantage of cooler burning conditions when a spot fire's growth would be slowed by fuel moisture conditions, areas specifically targeted for fuel reduction within the burn units may be browned by herbicide treatment prior to burning and the burn will only be conducted when live herbaceous fuel moisture outside the burn unit is calculated to be 100% or higher at the Makua Range weather station (WIMS 490301). To ensure that herbicide does not drift from the targeted areas to any areas outside the burn units, herbicide will only be applied by skilled pilots on days when wind conditions are conducive to application accuracy. The herbicided grass is highly flammable and will burn with high flame lengths and rates of spread, even under cool burning conditions early in the morning. Guinea grass, even with live fuel moistures over 100% and high dead fuel moistures, is still capable of producing flame lengths over 10 feet and high rates of spread so sufficient suppression force will be required to contain spot fires. Burned grass areas remain hot and inaccessible to firefighters long after the fire front has passed.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Spot fires are a substantial concern at Makua. Maximum spotting distance and spot fire size are minimized by burning under light wind conditions.

Final Rating: *Low* *Moderate* ***<u>High</u>***	Koa howlie shrubs are particularly prone to causing spot fires and this shrub grows in the burn units. The perimeter firebreak road is narrow enough that flame length may permit the fire to slop over the road if ignition is not conducted appropriately.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Need to mitigate for potential extreme fire behavior by burning under relatively cool burning conditions. Need to protect listed species from fire by managing grass fuels.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	To better ensure a high reliability organization during the implementation of the prescribed burn, several issues will be dealt with prior to ignition, including hooking up and testing all helicopter water buckets, testing communications, and completing grass control efforts in the vicinity of "manage for stability" populations of listed species in Lower Ohikilolo Management Unit.

6. Management Organization

Risk	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Burn requires substantial coordination with National Weather Service fire desk forecasters, military and civilian contract helicopters, Army fire staff, and other Army and interagency fire personnel.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Several agencies will participate in the prescribed burn. Highly skilled NWCG – qualified personnel and personnel from other fire agencies with substantial local experience will be assisting with the burn.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Lack of coordination resulting in the lack of a detailed spot weather forecast, poor road maintenance, or the lack of sufficient qualified ignition and holding resources would result in a no-go decision for burning. Poor press coverage would hamper the Army's credibility and future ability to manage the site successfully.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Rescheduling the burn due to a no-go decision may require additional herbicide if previously treated areas have greened up. Poor press coverage can be mitigated by working with Public Information Officer.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Substantial coordination will occur prior to and during the burn to ensure that all necessary activities are coordinated.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Substantial coordination will occur prior to and during the burn to ensure that all necessary activities are coordinated.

7. Public and Political Interest

Risk	**Rationale**

Preliminary Rating: *Low* *Moderate* ***High***	This area is very controversial, and a burn will be controversial. Escapes have occurred in the past, and were major media events.
Final Rating: *Low* *Moderate* ***High***	Successful, professionally conducted prescribed burns will result in increased trust in the Army's work at Makua. Regardless of the success of prescribed burns, Army activity in Makua valley is likely to remain a concern to many interest groups.

Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Escaped prescribed burns damage cultural, scenic, aesthetic, and natural resources.
Final Rating: *Low* *Moderate* ***High***	Successful, professionally conducted prescribed burns will result in increased trust in the Army's work at Makua. Regardless of the success of prescribed burns, Army activity in Makua valley is likely to remain a concern to many interest groups.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	The Army public relations office can work with the public and media to engender support for the prescribed burn. Prescribed weather and fuel moisture conditions must be substantially limited, and suppression forces must be substantial to ensure that resources are protected.
Final Rating: *Low* *Moderate* ***High***	Public relations and coordination of substantial suppression resources are scheduled to ensure that resources are not damaged by the prescribed burn.

8. Fire Treatment Objectives

Risk	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	The continuous grass fuel burns readily, however, at high live herbaceous fuel moistures, burns have historically been patchy.
Final Rating: *Low* ***Moderate*** *High*	Herbicide may be applied to areas which must burn to ensure complete consumption and to further aid in grass fuel reduction on the site.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	If we miss burning any targeted burn areas, they can be re-treated with herbicide and burned after three to four weeks.
Final Rating: *Low* ***Moderate*** *High*	Because all holding forces would be necessary for the second burn, the second burn would approximately double the cost of the burn. The financial costs associated with this burn are substantial.
Technical Difficulty	**Rationale**

Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	It is not difficult to identify dried areas from the air or ground, so the target burn areas will be easy to find. Depending on fuel moisture and weather conditions, it may be moderately difficult to burn the unit.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	It is not difficult to identify dried areas from the air or ground, so the target burn areas will be easy to find. Depending on fuel moisture and weather conditions, it may be moderately difficult to burn the unit.

9. Constraints

Risk	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Endangered species stabilization, fuelbreaks and firebreaks, and fire suppression contingency force planning, and burn preparation are expensive and require substantial commitments from Army environmental and fire staffs.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	A spot weather forecast with forecasted weather for each hour during the burn will enable the procurement of the appropriate contingent of air support for suppression of a spot fire to minimize costs. Fuelbreak and firebreak completion will further reduce costs.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	If the objectives are not being met or if weather conditions go out of prescription, we will extinguish and postpone the burn. It will take approximately one hour for the helicopters on site to extinguish the burning edge of the fire, partitioning it from the unburned portion of the burn.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	If the spot weather forecast called for all weather conditions to be in prescription for the duration of the burn and one hour after ignition, and the fire escapes due to an unexpected weather event, the Army does not bear such a burden of blame for the escape.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Funding, spot weather forecast requests, and resource ordering will be moderately difficult to coordinate.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Funding, spot weather forecast requests, and resource ordering will be moderately difficult to coordinate.

10. Safety

Risk	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Unexploded ordinance (UXO) may detonate when it is burned. Air and ground resources are on different radio frequencies. Herbicided grass may be hazardous to firefighter health.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Firefighters and helicopters must follow standard operating procedures when igniting burn unit and fighting spot fires in order to reduce exposure to unexploded ordinance. Firefighters will be positioned to limit exposure to smoke from herbicided grass.

Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	The consequences of a UXO detonation could be hearing loss, trauma, or fatality if a firefighter is in the burst radius.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Briefings will be provided to all resources to ensure understanding of the mitigation measures needed to minimize risk associated with UXO and herbicide.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	Substantial mitigation measures need to be instituted in order to reduce firefighter exposure to UXO and herbicide smoke.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Standard operating procedures have been developed ahead of time so that all resources can be briefed on limiting exposure to UXO and herbicide smoke. Use of helicopters substantially reduces firefighter exposure to UXO.

11. Ignition Procedures/Methods

Risk	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Technical expertise has been specified by the plan in order to control ignition sequence in order to prevent spot fires. The burn will be cut off when weather parameters hit prescribed limits to ensure that no spot fire is ignited under other than the prescribed conditions. In order to reduce the chance of fire spread if weather parameters go out of prescription, the interior of any large expanses within the burn unit will be ignited to keep it relatively even with the edges. This may require the use of flare guns or aerial ignition in the interior of the burn units.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	If grass is treated with herbicide it will not be difficult to black line by hand. No ignition of the burn area perimeter will be conducted from the air unless there is an area 60 meters or wider between the burn area and the firebreak road which is either mowed grass with live herbaceous fuel moisture content over 200% or otherwise treated vegetation that is not likely to burn. Aerial ignition will not be conducted immediately adjacent to any perimeter firebreak road until the firebreak road has been blacklined by hand.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***<u>High</u>***	The results of a mistake in ignition may be a spot fire and a threat to endangered species.
Final Rating: *Low* *Moderate* ***<u>High</u>***	Ignition procedures have been designed to minimize the likelihood of a spot fire, but a spot fire may still occur.
Technical Difficulty	**Rationale**

Preliminary Rating: *Low* ***Moderate*** *High*	Firefighters skilled in ignition and holding will be needed to conduct blacklining along the perimeter of the unit.
Final Rating: *Low* ***Moderate*** *High*	Preparation of the perimeter of the unit with herbicide will reduce the difficulty the ignition crew will have with blacklining operations. Aerial ignition will be conducted by a highly skilled pilot with many years of aerial ignition experience in Guinea grass fuels. Because holding will rely heavily on the use of helicopter bucket operations, the technical difficulty of ignition remains moderate.

12. Interagency Coordination

Risk	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Several agencies will be contributing skilled personnel to the burn. The Army is in a period of building trust with other agencies and the public following recent escaped prescribed burns at Makua.
Final Rating: *Low* ***Moderate*** *High*	Skilled personnel from many agencies will assist with planning and implementation of the burn. If the burn escapes and the Army used this best available weather data and drew on the best available expertise, the Army would limit their exposure to law suits.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* *Moderate* ***High***	Disagreement between the agencies, or finger pointing in after-actions of an escape are very damaging to agency cooperation. However, assistance from available skilled specialists from other agencies in Hawaii, including experts from the National Weather Service, National Park Service, US Forest Service, and the US Fish and Wildlife Service and using skilled ignition and holding personnel from other agencies could increase the likelihood of a successful outcome to the burn.
Final Rating: *Low* *Moderate* ***High***	Skilled personnel from many agencies will assist with planning and implementation of the burn. If the burn escapes and the Army used this best available weather data and drew on the best available expertise, the Army would limit their exposure to law suits.
Technical Difficulty	**Rationale**
Preliminary Rating: *Low* ***Moderate*** *High*	Army staff must maintain cooperative agreements and have protocols in place for ordering resources to fill prescribed fire positions.
Final Rating: *Low* ***Moderate*** *High*	The Army has protocols in place for ordering Army and civilian contract helicopter support, and assistance from Navy Fed Fire Depatrment, PTA firefighters from the Big Island. The National Weather Service has developed a new internet-based spot weather forecast for prescribed burns. Given updated cooperative agreements, US Department of Interior and Agriculture personnel could be available, free of charge, to the Army to fill skilled positions on the prescribed burn.

13. Project Logistics

Risk	Rationale
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Many logistical tasks must be completed ahead of time to ensure that all needed supplies and equipment are on site for the burn. Helicopter fuel must be on site during the burn. No food or overnight accommodations other than tents are available at Makua.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Planning and pre-positioning will ensure that logistical needs will be satisfied.
Potential Consequences	**Rationale**
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	If any required item is missing, we would need to postpone the burn.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	If any required supplies are missing, we will postpone the burn.
Technical Difficulty	**Rationale**
Preliminary Rating: ***<u>Low</u>*** *Moderate* *High*	Planning will mitigate this factor.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Planning will mitigate this factor. Many logistical tasks will be completed ahead of time to ensure that all supplies and equipment are on site for the burn.

14. Smoke Management

Risk	Rationale
Preliminary Rating: *Low* ***<u>Moderate</u>*** *High*	Paved public road leading to relatively low use beaches adjacent to Makua may be crowded with onlookers. Need to monitor smoke on public road and post speed limits according to visibility. Accidents may occur which are unrelated to prescribed burn's smoke so smoke and visibility monitoring will be necessary to ensure the smoke does not contribute to an accident. Set up temporary prescribed burn signs on public road. Smoke may cause the greatest concern just before sunrise when smoke dispersion and visibility in general is still poor. However, very little traffic is expected in the Makua area so early in the morning. Good daytime dispersion will minimize smoke on road. Residual smoke will be limited due to rapid consumption of grass fuels.
Final Rating: *Low* ***<u>Moderate</u>*** *High*	Smoke conditions on Farrington Highway will be monitored and traffic will be controlled if necessary if visibility becomes a concern.

Potential Consequences	**Rationale**
Preliminary Rating: ***<u>Low</u>*** *Moderate* *High*	An accident on the public paved road resulting in injury or private property damage could be blamed on a smoke-related visibility issue. Need to monitor and document smoke and visibility on the highway during the prescribed burn. Need to institute nationally recognized smoke management plan for setting speed limits, controlling traffic with escorts, and closing the road.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Visibility will be monitored and documented on the public paved road during the prescribed burn per the smoke management section of the plan. Traffic controls, including speed limit restrictions, escorts, and road closure will be applied according to the smoke management section of the plan.
Technical Difficulty	**Rationale**
Preliminary Rating: ***<u>Low</u>*** *Moderate* *High*	Will need to check weather forecasts and get a spot weather forecast and be vigilant. Smoke from dried vegetation will be minimal.
Final Rating: ***<u>Low</u>*** *Moderate* *High*	Smoke conditions on Farrington Highway will be monitored and traffic will be controlled if necessary if visibility becomes a concern.

<u>ANALYSIS OF OVERALL COMPLEXITY – North Lobe Firebreak Road</u>

Hazard Element	**Complexity Value**		
	L	**M**	**H**
1. Potential for escape			**x**
2. Number and dependency of activities		**x**	
3. Off-site values			**x**
4. On-site values	**x**		
5. Fire behavior			**x**
6. Management organization		**x**	
7. Public and political interest			**x**
8. Fire treatment objectives		**x**	
9. Constraints		**x**	
10. Safety			**x**
11. Ignition procedures/methods		**x**	
12. Interagency coordination		**x**	
13. Project logistics		**x**	
14. Smoke management	**x**		
Total	**2**	**7**	**5**
Resulting Determination	**HIGH**		

SUMMARY COMPLEXITY RATING

Risk, Consequences and Difficulty	L	M	H
Risk	1	8	5
Potential Consequences	2	2	10
Technical Difficulty	3	8	3
Total	6	18	18
Resulting Determination	HIGH		

QUALIFICATIONS DETERMINATION TABLE

	RxB3	RXB2	RXB1
Number of factors rated at Low, Medium and High in the Hazard Complexity Analysis	Extremely low complexity burns	Less than 4 factors are rated "high"	4 or more factors are rated "high" **OR** when deemed appropriate by the agency administrator or unit Fire Management Officer.
Prescribed Fire Burn Boss Level Indicated (check one):			X

Overall Complexity and Rationale:

Both the tables above indicate an overall complexity of **High.**

Prepared by: ______________________ Date: December 11, 2006

Jason Greenlee, RxB2

Approved by: ______________________ Date: ____________

(Agency Administrator)

SECTION 7
COMMUNICATION PLAN (Contact Information Will Be Updated Periodically)

A. Notify by letter

Kenneth Silva	Honolulu Fire	letter: 3375 Koapaka Street, Ste H425, Honolulu, HI 96815 ksilva@honolulu.gov
Glen DeLaura	Federal Fire Dept	letter: 850 Ticonderoga Street, Ste. 106, Pearl Harbor, HI 96860-5102 glenn.delaura@navy.mil 473-5723 cell 306-6756

B. Submit plan and Record of Environmental Consideration (REC)

Dale Kanehisa	DPW, Environmental	
Peter Yuh	DPW, Environmental	
Gary Shiratata	Army Corps of Eng	gary.n.shirakata@ponu1.usace.army.mil
Uyen Tran	Army Corps of Eng	

C. Notify by email confirming burn schedule

Bobby Abad	Federal Fire Dept	668-3420 Robert.abad@navy.mil
Patrice Ashfield	US Fish and Wildlife	792-9400 patrice_ashfield@fws.gov
Bill Bouley	US Army IFSO	656-9540
Dan Brown	Federal Fire Dept	590-7729 browndk@navy.mil
Tommy Casserly	Federal Fire Dept	590-7736 cell Thomas.casserly@navy.mil
Wayne Ching	State Protection	587-4173 wayne.f.ching@hawaii.gov
Pat Costales	Hawaii DNR	973-9787 patrick.g.costales@hawaii.gov
Glen DeLaura	Federal Fire Dept	473-5723 (o) 306-6756 (c) glenn.delaura@navy.mil
Michael Donnelly	US Army PAO	655-9997
Gayland Enriques	Federal Fire Dept	473-0343 (o) 225-5938 (c) gayland.enriques@navy.mil
Alton Exzabe	US Army Arch	656-2878
Sharon Frank Howard Estebrook Tom Hauptman Lawrence Guillermo Brad	Pacific Helicopters	9-7-808-871-9771 cell 9-7-808-870-2152 479-1492 sharon@pacheli.com request a fuel truck with helicopters 781 7783
Victor Garo	Army Range Control	655-1404
Joel Godfrey	Army Environmental	656-2879 x 1050
Dawn Greenlee	U.S. Fish & Wildlife	792-9469 (o) dawn_greenlee@fws.gov
Jason Greenlee	Army Fire	656-1331 jason.m.greenlee@us.army.mil
John Highfill	US Army G3	655-8212
Walt Hilgreth	Zapeta Engineering	630-4352 whildreth@zapeng.com
Sammy Houseberg	US Army IFSO	656-3550
Eddie Kaai	US Army DPTM	696-4892
Kevin Kodama	National Weather Serv	973-5276 Consult on drought effects on fire behavior Kevin.kodama@noaa.gov

Jeff Lefebvre	Army Air Quality	656-2878 x 1059
Laurie Lucking	Army Archeology	656-2878 x 1052
Michelle Mansker	DPW, Environmental	656-2878 x 1029
Eric Moller	US Army IFSO	99-433-1810, 1, 441#
Elena Onaga	US Army Attorney	438-2291
Salvadore Petrovia	US Army G3	655-4084
Tommy Piskel	US Army Contractor	655-1597
Jeff Powell	National Weather Serv.	973-5280(fax 973-5281) jeffrey.powell@noaa.gov
Frank Raby	Range Control	655-1990
William Roome `	US Army PAO	655-0760
Gary Shirakata	US Army Corps Eng	438-0772
Kenneth Silva	Honolulu Fire	ksilva@honolulu.gov
Ken Torre	Range Control	655-9509
Kendrick Washington	Army Public Relations	656-4221
Peter Yuh	DPW, Environmental	656-2878 x 1051 Consult about REC document

The following email addresses are on my desktop in a word file for emailing messages about the status of a burn:

patrick.g.costales@hawaii.gov; gary.n.shirakata@poh01.usace.army.mil; Patrice_Ashfield@fws.gov; Dawn_Greenlee@fws.gov; thomas.casserly@navy.mil; robert.abad@navy.mil; Godfrey, Joel E CIV USAG HI DPW; sharon@pacheli.com; wayne.f.ching@hawaii.gov; glenn.delaura@navy.mil; ksilva@honolulu.gov; browndk@navy.mil; Bouley, William R CIV USA USARPAC USAG HI SAFETY; whildreth@zapeng.com; jeffrey.powell@noaa.gov; Gayland.enriques@navy.mil; Kevin.kodama@noaa.gov; Onaga, Elena J CIV DIV L 25 SJA; Garo, Victor Jr CIV USAG HI DPTM; Petrovia, Salvatore J LTC HHC DIV 25ID G3; Greenlee, Jason M CIV USA USARPAC USAG HI SAFETY; Torre, Kenneth P CIV USAG HI DPTM; Yuh, Peter CIV USAG HI DPW; Mansker, Michelle L CIV USAG HI DPW; Lucking, Laurie CIV USAG HI DPW; Kaai, Eddy CIV USAG HI DPTM; Houseberg, Sammy CIV USA USARPAC USAG HI SAFETY; Highfill, John D MAJ USA USARPAC DIV 25 BDE 2 CAV 5 14; Piskel, Thomas P CTR USAG HI DPTM; Ching, Susan N CIV USAG HI DPW RCUH; Raby, Franklin D USAG HI DPTM; Donnelly, Michael O LTC DIV 25 PAO; Exzabe, Alton J CTR USAG HI DPW RCUH; Lefebvre, Jeffrey S CIV USAG HI DPW; Roome, William H 25 ID PAO; Washington, Kendrick CIV DIV 25 PAO; KatkowM@SHAFTER.ARMY.MIL; Gardin, Stefanie A CIV DIV 25 PAO; Payne, Shanon A CTR USAG HI DPTM; Borja, Berno S CIV USAG HI DPTM; Lai, Steve C CIV USAG HI DPTM

C. Notify on day of burn

Honolulu Fire Department	523-4411
State Forestry	587-4173
Dept. of Health, Clean Air Branch	586-4200

RADIO COMMUNICATIONS

Find the radio communication plan in the Incident Action Plan (attached).

An LCES check will be made periodically by the burn boss or his/her designated person. All personnel on the burn will respond with “LCES in place” when the check is called for.

SECTION 8
IGNITION PLAN

1. Briefing

Sand-box drills and briefing schedules will be announced by email. All resources on the burn are required to attend the final briefing. Briefings are mandatory. Everyone involved with the prescribed burn will be briefed prior to implementation. Briefings will cover: objectives, organizational roles and assignments, LCES, ignition patterns and techniques, fire behavior, weather, contingency planning, safety hazards and precautions. Briefings will include graphic aids, such as aerial photos, road maps, etc. Some form of geographic reference, such as maps or copies of aerial photos, will be provided for personal reference to all crew members unless the entire burn area can be seen from every position on the burn.

2. Test Burn

A test burn will be conducted prior to ignition. All of the resources required to be on-site for the prescribed burn will be at the test burn or at least on site, and will be checked in with the staging area manager and/or Operations Section. The test burn may not occur until the assigned helicopters are on-site, tested, and able to fly ½ hour prior to sunrise. The test burn area will be selected during the briefing at an area convenient for extinguishing the burn and with wind direction in consideration. The Burn Boss or Ignition Boss will be present to ensure the test burn is completed properly. Test burn results will be documented, the crew will be provided with a briefing, and job hazard analysis will be included in the briefing. A spot weather forecast will be obtained prior to test burn (required for every day of the burn on Type 1 and T2 burns and recommended for T3). Completion of a test burn will be relayed to all resources.

3. Ignition sequence

A. Type equipment which may be used for ignition

(x) Drip torches
(x) Aerial ignition (plastic spheres or aerial torch)
(x) Motorized torches (ATV, terra torch)
(x) Other ground-based incendiaries (fusees, flare guns)

C. Ignition Pattern

A lookout will be posted on high ground or other place with a good view of 100% of the burn area.

The Burn Boss will brief the ignition pattern for the burn prior to the test burn, using a sand table, if available.

The following is an example of an ignition pattern that is planned for a small burn at MMR.

"Resources will initially stage at Point D on the map below for the test burn, which will be lit at 0700 on the day of the burn. Helicopters will be warmed up and ready to lift off with buckets, Point D contains a dangerous "dog leg" of fuel that will be burned before onset of the rest of the burn. Firing teams will move from the dog-leg, once completed, northward toward E and then F, continuing to fire cautiously. Army holding teams will follow at prescribed distances, watching for spots over the line. Once F has been reached and the line from D to F is secure, two teams will slowly pull fire along the rim of Gulley A-E. The team starting at D will move slowly toward C. The team starting at F will move slowly toward G. Both teams will make an effort to keep their fires on line across the gully. The D to F road will continue to be patrolled during the entire burn. Once C and G are reached (or at such time as the burn boss elects), firing teams will stop firing and move to Point A. Point A contains another dangerous dog-leg that will be carefully and slowly burned out before proceeding. Helicopters will wet A-H and A-B on the far side of the firebreak road to ensure against spotting. After helicopters have completed this mission, two firing teams will proceed slowly from A to B and from A to H, again coordinating their movements to avoid any unburned fuels from being left behind that can act as a wick and cause fire running and gaining momentum. Once H and B have been safely reached, the burn boss will decide whether to use the Jet Ranger and plastic sphere dispenser to complete the ignition operations."

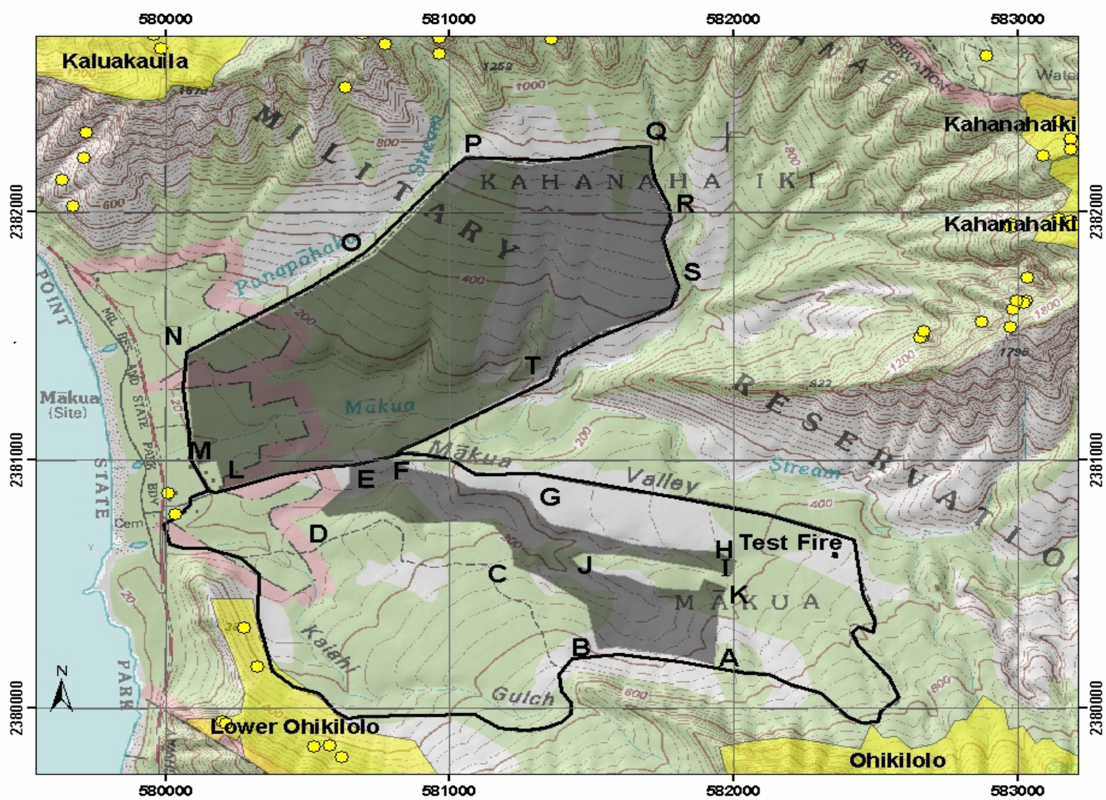


Figure 6: Example of an ignition plan for a small burn (Letters A through H) in the South Lobe of the Firebreak Road.

SECTION 9
HOLDING PLAN

Holding forces are noted in the organization chart. In addition to these personnel and engines, the following equipment will be on hand:

4 number of chainsaws
4 number of back-pack pumps
___ number of folda-tanks
___ number of ______________
___ number of ______________

The Burn Boss, Holding Boss, and crew will remain on scene until fire has burned down and threat of spotting or escape no longer exists, or until released by the Burn Boss.

CONTINGENCY PLAN

Two contingencies are anticipated on these burns – an escaped fire and a medical emergency. An escaped fire is defined as fire which has exceeded or is expected to exceed prescribed fire holding and contingency capabilities, prescription elements, or criteria established in the prescribed fire plan triggering the declaration of a wildfire.

A. Arranging for contingency resources for an escaped fire:

The Burn Boss will request availability of contingency resources from the Federal Fire Department in advance, as part of the planning process. If these resources are to be used, channels for communication will be agreed on.

B. Maximum Manageable Area (Figure 7) The Maximum Manageable Area (MMA) does provide for an anticipated potential 88 acre spot fire, which may burn in grass fuels outside the firebreak road. A spot fire burning any area outside of the Maximum Manageable Area, would be considered an escaped prescribed burn. Figure 7 shows the threatened and endangered species, management units, and designated critical habitat areas to be protected from a spot fire.

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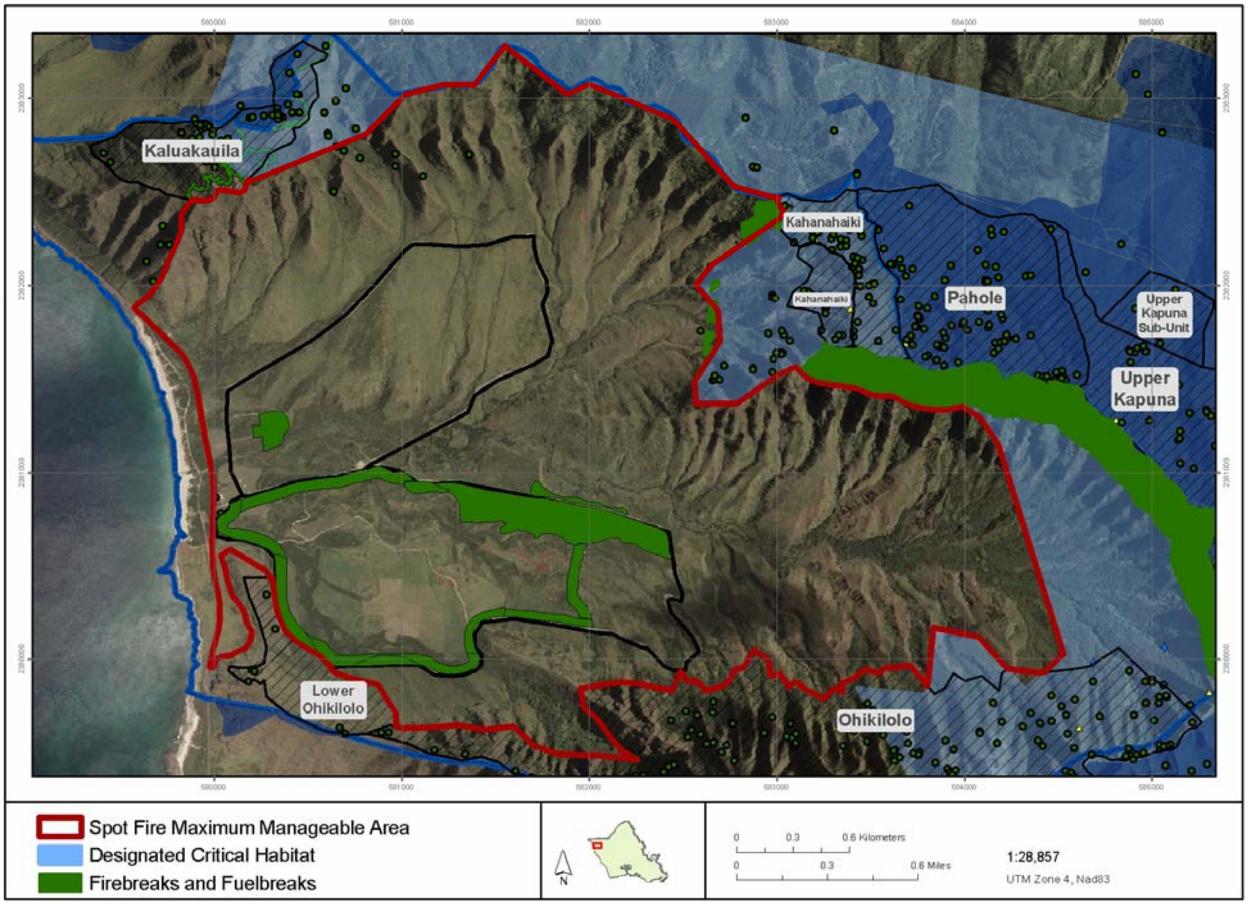

Figure 7: Maximum Manageable Area: The MMA is the area inside the installation which is not within a Management Unit or designated critical habitat. Prevent fire from burning into Rare Species Management Units, cross-hatched areas and shaded designated critical habitat areas. Spot fires up to 88 acres in size burning within the area bounded by the red line (MMA) would not be considered escaped prescribed burns.

C. Spot fires

If the fire spots outside the control lines this does not necessarily indicate an escape. An escape will be declared if the spot moves, or threatens to move, the fire outside the Maximum Manageable Area. If the fire spots across a control line, the following will be implemented:

1. Crew members will notify the holding boss and burn boss by radio.
2. All resources will be notified and should confirm notification.
3. All ignition will stop until the crew evaluates the spot(s).
4. The Burn Boss will review the contingency plan and the criteria for declaring an escape. The Burn Boss will plan or initiate any actions that will better prepare for declaration of an escape (notifying dispatch of a possible problem, moving holding resources, reassigning ignition resources, etc.).
5. If the Burn Boss has not already done this, a staging area for incoming resources should be designated and manned by a person familiar with the burn unit.

D. Notifications to be made if there are problems

1. Notification of spots over control lines:

Personnel witnessing spots will notify the holding boss by radio. All personnel on the fire will hear this news, and the holding boss will confirm that all personnel have been informed. The holding boss will also confirm that the holding crew is en-route to the location of spot and that the first personnel on site do a size up of the spot. The holding boss will confirm that all personnel have received the size up over radio.

2. Escaped fire notification

The burn boss is notified by holding boss or crew members if a spot cannot be contained by the resources on hand. The burn boss will consult with the Fire Manager and Fire Administration and a decision whether to declare an escape will be made. In the event of an escape being declared, the burn boss will notify the crew of a transition of command from the burn boss to an Incident Commander (IC). The burn boss will notify the IOC via telephone (655-8763, 655-8764) for the Incident Commander.

The Incident Commander or his delegated representative will request contingency resources through Federal Fire representatives on site.

Contingency equipment to be ordered if an escape is declared (this equipment will be confirmed on the day of burn):

Table 7. Contingency equipment requested in the event of the declaration of an escape

Equipment	Number	Source	Arrival Delay
T6 engines (150-400 gal)	2	Federal Fire Dept	15 minutes
Tender/tanker	1	Federal Fire Dept	15 minutes
T1 helicopter (700+ gallons)		US Army	90 minutes
T3 Helicopter (100-299 gallons)	Sufficient to meet Containment goals	Contract	
Air attack	1 (if more than 3 helicopters)	Fire 1(HFD)	60 minutes

3. IOC will notify:

The Commander.

4. The burn boss will assist the Incident Commander in expediting the following actions:

Obtain a spot weather forecast; convert organization to suppression organization; ensure IC gives briefing to resources; ensure a staging area and staging area manager is established; confirm to Incident Commander that all notifications were made.

5. Notifications of injury**:**

The burn boss notifies IOC via telephone and Federal Fire Department via radio or telephone. Burn boss refers to Medical Plan (Section 15); injured person is evacuated.

SPOT FIRE AND FIRE ESCAPE FIRE CHECKLIST

A. Notification of spots over control lines:

( ) Time: _______________Personnel witnessing spots notify Holding Boss by radio for all to hear
( ) Time: _______________Holding Boss confirms all personnel have been informed
( ) Time: _______________Holding Boss confirms that holding crew is en-route to location of spot and that first personnel on site will do a size up
( ) Time: _______________Holding Boss confirms that all personnel have received size up over radio

B. Notifications made on the fireline:

( ) Time: _______________Burn Boss is notified by crew member of a problem
( ) Time: _______________Fire Administrator determines whether to declare an escape
( ) Time: _______________Burn Boss notifies crew of change of command to an Incident Commander

C. Notifications made by burn boss:

( ) Time: _______________	Burn Boss notifies IOC	655-8763, 655-8764
( ) Time: _______________	Range Control	radio
( ) Time: _______________	Installation Fire and Safety Director	radio
( ) Time: _______________	Installation Fire Chief	radio
( ) Time: _______________	Federal Fire Department	474-2222
( ) Time: _______________	Honolulu Fire Department	423-4411
( ) Time: _______________	U.S. Fish and Wildlife	656-2878
( ) Time: _______________	Division of Forestry	587-4173

D. Records of steps taken kept by burn boss:

( ) Time: _______________ Obtain a spot weather forecast
( ) Time: _______________ Burn Boss converts organization to suppression organization
( ) Time: _______________ IC gives briefing to resources and ensures a staging area is established.
( ) Time: _______________ Burn boss and/or incident commander confirms that all notifications have been made.

E. Notifications to be made in case of injury:

( ) Time: _______________Burn Boss notifies dispatch via channel 1. Dispatch refers to Medical Plan, Section 16
( ) Time: _______________Injured person is evacuated by what means __________________

F. Medical Emergencies

If there is a medical emergency, the burn boss and safety officer will be notified. Any EMT's on site will respond. All firing operations will cease. Dispatch will be notified and updated. Dispatch will contact life-flight and confirm ETA, if appropriate. A medical plan is contained in this plan with contact numbers.

WILDFIRE CONVERSION

The fire may spot over control lines may not necessarily be considered an escape, unless burns designated critical habitat or a portion of a Management Unit (Maximum Allowable Area) (map attached). Only the Fire Administrator or a designated representative will declare an escape. The burn will be declared an escape:

1. As soon as it is evident that fire is likely to exceed the Maximum Manageable Area, or

2. If contingency resources are requested by the Holding Boss, or
3. If suppression funds are expended, or
4. As soon as it is evident that any of the other following trigger points are about to be reached:

( ) ____
( ) ____
( ) ____

Actions to be Taken When an Escape is Declared:

1. If an escape is declared, all ignition will be stopped, and all forces on hand will take suppression action.

2. There will be no hesitation in notifying local agencies and contingency resources. It is understood that delay may be considered a negligent act. Immediate notifications to involved personnel and agencies, as per the Communication Plan are critical.

3. A transition will take place between the burn boss and an incident commander. The incident commander will be the individual holding the holding boss position on the prescribed burn. The personnel will be notified of this transition by radio, and will acknowledge that information.

4. After sizing up the situation, the incident commander will hold a briefing of all personnel. Depending on the situation, some personnel may be briefed by radio.

5. Records will be initiated by the burn boss of notifications made, persons answering the notifications, actions being implemented, resources being sent, and times of notifications. The following documentation will be initiated for the Wildfire Situation Analysis (WFSA) preparation and other documentation:
   a. time of escape declaration
   b. who was notified
   c. which contingency resources were requested
   d. which resources confirmed they were on the way
   e. what times the contingency resources indicated they would arrive
   f. what times the contingency resources arrived
   g. document briefing of the contingency resources
   h. environmental conditions
   i. fire/weather observations
   j. actions prior to and after escape (chronology of events)
   k. unit logs and individual statements
   l. weather forecasts
   m. spot weather forecasts (obtain this now, as you are now in suppression mode)
   n. data from the nearest weather station (to be obtained by dispatch)

6. Notifications of an escape: Consult the Communications Plan for a notification list in the event of an escape.

7. WFSA. A Wildfire Situation Analysis will be prepared in advance, and no more than eight hours after declaration of an escape.

ESCAPED FIRE SITUATION ANALYSIS (EFSA)

Fire Management Area: Makua Range, Oahu

Location: The Makua Range is located on the west side of Oahu on the coastal road past Makaha.

Fire Name: Makua MMR-06-03

Fire Grid Coordinates:

Date:

Land Status: The area is either leased or owned by the U.S. Army

Adjacent Landowners: U.S. Air Force to the North and private to the south.

Fire Management Option(s): Full Protection Management Option. All fires in these designated areas will receive aggressive suppression effort until the fire is declared out. This option is designed for the protection of high natural resource value areas, and cultural and historical sites found within or adjacent to the fire management area.

This information is used as a pre-attack Escaped Fire Situation Analysis (EFSA) to provide guidelines to the Prescribed Burn Manager for the development of a joint EFSA with the Federal Fire Department (FFD), DOFAW, and City and County of Honolulu Fire Department under the Unified Command Situations of the Incident Command System (ICS).

1. EVALUATION CRITERIA (Check those criteria which MUST be met): MUST

a. Economic:	Government Facilities	……………………….X
	Military Targetry Equipment	……………………….
	Road and Trail Network	……………………….X
b. Environmental:	Watershed Influences	……………………….
	Threatened and Endangered Species	……………………….X
	Wildlife Habitat	……………………….X
	Soil Protection	……………………….
	Natural Forest Reserves	……………………….X
c. Social:	Air Quality	……………………….
	Shoreline Aesthetics	……………………….X
	Hunting, Fishing Habitat	……………………….
	General Outdoor Recreation (Camping, hiking, etc.)…………	
	Firefighter and Public Safety	……………………….X
	Public Concerns	……………………….X
d. Other:	Archeological and Cultural Resources	……………………...X
	Neighboring Lands	……………………….X

2. ALTERNATIVES

Alternative	A	B	C	D
General Plan of Control (Strategic)	Full fire control of all fires within burn unit(s)	Contain within Makua firebreak roads	Contain within Makua installation boundary	Contain to Waianae Range
Specific Plan	Direct attack of perimeter	Direct/Indirect attack along MMR firebreak roads	Direct/Indirect attack from fuel breaks and along perimeter Modified Suppression Actions	Direct/Indirect attack from fuel breaks and along perimeter Modified Suppression Actions

Probability of Success	97%	90%	75%	50%
Size (Predicted)	250 acres	<1500 acres	<4500 acres	>5000 acres
Estimated Control Time	< 2 hours	< 8 hours	>12 hours	> 24 hours

3. RESOURCES REQUIRED

Alternative	Firefighting and Logistical Resources	Estimated Cost
A	IFSO, Range Division, Aviation Support, Fed Fire	$5-10K
B	IFSO, Range Division, Aviation Support, Fed Fire	$10-15K
C	IFSO, Range Division, Aviation Support, Fed Fire, G3, Honolulu Fire Dept, Division of Forestry & Wildlife	>$15K
D	All Wildland Fire Cooperative Resources	>$50K

3.SELECTED ALTERNATIVE

A. Selected Alternative: A then B then C and then D.
B. Justification: (Document the rationale, criteria, value change, available resources, etc., for selection of this alternative).
   a. Full suppression of wildfire is the order.
   b. Direct attack, going indirect when necessary to contain fire at the smallest size possible, in the shortest period of time.
   c. Human values at risk from modified suppression actions.
   d. Unified Command with RDH, FFD, HFD, DOFAW for management of the fire incident.
   e. Pre-attack guidelines are in the Wildland Fire Management Plan, dated March 2000.
   f. Potential threat and damage to Threatened and Endangered Species habitat areas.
   g. Native forest will convert to alien-dominated savanna and grassland types.

C. Public Information Direction: (Keeping public informed of situation)
   a. Refer to Army Public Affairs Office (PAO).
   b. IC will designate Information Officer.
   c. Cooperation with Oahu Civil Defense Center for complex situations.

SECTION 10
SMOKE MANAGEMENT AND AIR QUALITY

Air sheds, restricted areas, non-attainment areas, population centers, highways, airports, recreation sites, and other smoke sensitive receptors that could be impacted were identified (Figure 8).

Particulate matter and chemical components of smoke can be hazardous to the public. Maximum allowable concentrations are set by the Environmental Protection Agency and are know as National Ambient Air Quality Standards (NAAQS). Smoke emissions from this prescribed burn will not result in non-attainment of NAAQS on the public highway, beaches, camping areas, or towns in the area. However, if any area in the state has already reached non-attainment or there is a threat of non-attainment from point sources other than the prescribed burn, the State will declare a no-burn day. The burn boss or designated person will call the State of Hawaii Department of Health, Clean Air Branch to ensure that is a permissive burn day for the selected area (as provided in Hawaii Administrative Rules, Section 11-60, 1-55).

Visibility on the paved public road may be impacted by this prescribed burn and nationally accepted mitigation measures will be put in place to ensure safe traffic movement on the road during the burn. A monitor will document visibility on the road every fifteen minutes during the burn. If visibility for road traffic becomes a public safety concern, posted speed limits may be reduced,

The following guidelines will be put in place in the event that a roadway is impacted by smoke so that public safety will not be compromised:

Table 8A. Road Control Guideline for Two Lane, Two Way Road, Day Light Hours

Posted Speed Limit	Minimum Acceptable Visibility
10 mph	56 feet (if less than 56 feet, begin one-way traffic control)
15	100 feet
25	216 feet
35	370 feet
45	566 feet

Table 8B. Road Control Guideline for Two Lane, Two Way Road, Night Time Hours

Posted Speed Limit	Minimum Acceptable Visibility
10 mph	112 feet (if less than 112, begin one-way traffic control)
15	200 feet
25	432 feet
35	740 feet
45	1132 feet

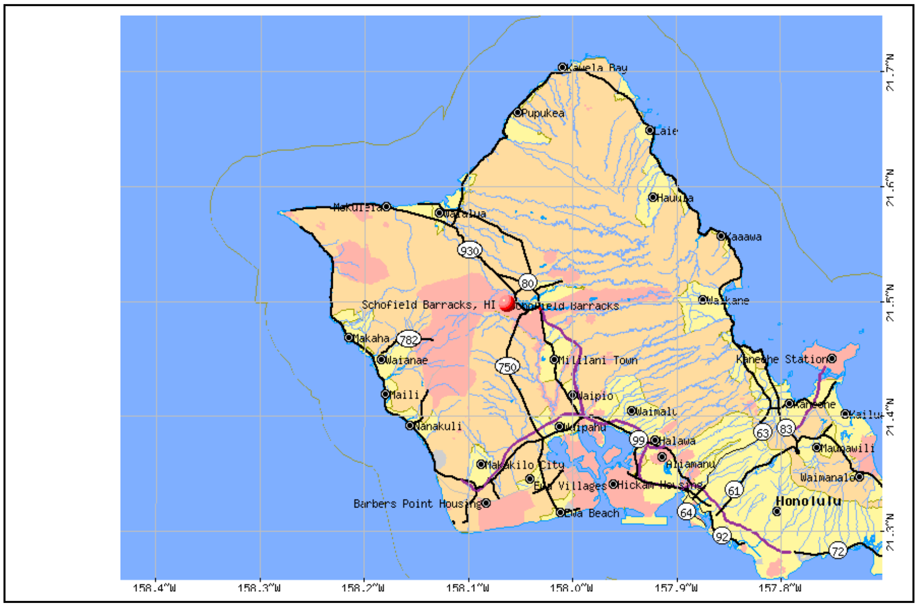

Figure 8.   Smoke sensitive areas.

MONITORING

The following monitoring will be done prior to the burn: Photographs of the burn area will be taken from vantage points that are easy to relocate. The location of the camera will be marked on a map.

The following monitoring will be done during the burn: Photographs of the burn area will be taken from the same vantage points.

The following monitoring will be done after the burn: Photographs of the burn area will be taken from the same vantage points.

POST-BURN ACTIVITIES

After burning is completed, any resource damage that occurs will be repaired (water barring, scattering burns, etc.). A checklist is provided in the documentation section, Element 22.

( ) Time/Date: _______________ Documentation completed and filed
( ) Time/Date: _______________ Hazard trees extinguished and/or put on ground
( ) Time/Date: _______________ Roadside culverts cleaned-out, if needed.
( ) Time/Date: _______________ Fence lines inspected and repaired
( ) Time/Date: _______________ Water bars installed on hand-lines
( ) Time/Date: _______________ Soil sterilization work completed, if needed.
( ) Time/Date: _______________ Visual quality mitigation completed
( ) Time/Date: _______________ Notify appropriate persons of any adverse impacts
( ) Time/Date: _______________ Declare fire out and record date on cover sheet

SECTION 11
SAFETY

Personnel: Work/rest guidelines are the same for prescribed burning as for wildfires. A qualified Safety Officer (minimum of Type 3 qualified SOF) will be assigned to all high complexity prescribed fires and on fires in which any one of the final ratings of the three “Factors” of the “Safety Element” in the Complexity Analysis are rated high. The organization chart, responsibilities, and qualifications will be reviewed. The Burn Boss, Holding Boss, Ignition Boss and other key individuals will be identified. If any changes of leadership are made during the burn, this change will be announced and acknowledged by all individuals on the burn over the radio. An Ignition Boss with fire behavior training and experience will be in charge of the firing operation. Fire behavior expertise and qualifications of the Ignition Boss must be consistent with the complexity of the burn (FFT1 for Low Complexity, RxI2 for Moderate Complexity and RxI1 for High Complexity burns).

Safety standards: All wildland fire safety standards and guidelines will be followed (i.e. 10 fire orders, 18 Watch Out Situations, LCES, and Common Denominators of Fire Behavior on Tragedy Fires, Situational Awareness and Risk Management). The risk management process identified in the NSCG Incident Response Pocket Guide (IRPG, PMS 410-1) helps ensure that critical factors and risks associated with prescribed fire operations are considered during decision making. This process will be applied to all prescribed fire planning and operations.

Briefing: At the briefing, unique safety hazards will be described and a Job Hazard Analysis (JHA) will be covered.The burn crew organization will be clearly defined. Lines of authority will be discussed. The importance of following instructions will be stressed. A project briefing before each burning will clarify fire orders, organization responsibilities and backup plans. Safe use and peculiarities of all equipment and firing devices will be covered. The hazardous characteristics of the area to be burned, such as snags, heavy fuel concentrations, poor footing, loose rocks, terrain, expected fire behavior, safe islands, rolling logs, burning in the vicinity of power lines, unnecessary yelling, radiant and convective heat, transportation and proper identifying flammable fuels. LCES will be in place before operations are initiated. LCES will periodically be verified by supervisors during the operation. The hazards of fuel mixtures used in burning will be discussed. Fuel mixtures will never exceed one gallon of gasoline to four gallons of diesel. The crew will be reminded to keep fuel off clothes. If clothing becomes saturated with fuel, change immediately. The crew will be reminded to use gloves when handling fuel. Clean rags to remove fuel from face and hands will be provided. Crew members will be instructed to wash smoke and fuel residue from hands and face whenever possible. Crew members will be reminded to never pour fuel on the ground or throw it onto flames. Crew will be reminded that excess fuel will be returned to the bulk container. Crew members will be warned about inhaling smoke over extended periods of time. Public safety will be planned, including school bus schedules. A decision will be made whether signing and traffic control are needed.

Debriefing: To ensure enhanced safety in operations, a debriefing will be held after every operational period. The debriefing format will be such that it will encourage open communication and follow-up on items to be monitored and improved in the next operational period.

Transport of any product containing chemicals: transportation and use of any product containing chemicals (drip torch fuel, aviation gas, sphere dispensers, fusees, fuel thickener, etc.) must be in compliance with the Occupational Safety and Health Administration’s (OSHA) Hazard Communication Standard, 29 CFR 1910.1200 and Department of Transportation Regulations (49 CFR part 171), and agency specific guidance. Material Safety Data Sheets (MSDS) for hazardous materials used on projects should be consulted in developing the JHA.

Crew dynamics: The burn boss will engage the crew assertively, positively and in an affirmative manner before, during and after the burn execution. The burn boss will ensure that lines of communication are open, and will continue to check lines of communication throughout the burn. The burn boss will brief the crew to make haste slowly. Do not be rushed, but be deliberate and methodical, keeping the safe and successful attainment of resources and operational objectives as a focus. A fresh safety briefing will be held each burning period/shift. Situational awareness will be discussed with the crew, and it will be emphasized that each person is responsible to speak up if comfort levels are exceeded. Situational awareness before and during the burn is critical to successful outcomes. Pay attention to any sense of discomfort with organizational, strategic, tactical, and environmental factors before and during project execution. Analyze, make adjustments, and document appropriately.

Equipment: All personnel will have a map or aerial photo for reference to their location, the location of other resources, escape routes, and check-in points for contingency resources. The map will be marked with location numbers or other indications for reference over the radio. Personnel will wear all Personal Protective Equipment (PPE) and shall meet health, training and physical requirements. PPE shall be the same as that is required for fire fighting and shall be worn by all personnel while implementing or visiting the prescribed burn. Communication equipment will be provided and the Burn Boss will ensure that workers understand its operation. Each person will ensure that his/her equipment is working properly. The crew will be reminded to park and secure vehicles in a safe area away from flames, chocking wheels, if needed.

LCES check: A periodic LCES check will be made on the radio, with all units reporting back that they have LCES in place, and with the RxB recording the time and responses (see Checklists attached).

Safety Officer: A Safety Officer will be assigned (any Type 1, 2, or 3) to a High Complexity prescribed fire.

RISK ASSESSMENT FACTORS

Severity of the hazard (Expected consequence of an event in terms of degree of injury, property damage, or other mission/task impairment.):

Catastrophic - Death or permanent total disability, system loss, major property damage.

Critical - Injury resulting in permanent partial disability or temporary total disability in excess of 3 months, major system damage, significant property damage.

Marginal - Minor injury, lost workday accident, or compensable injury or illness; minor system damage; minor property damage.

Negligible - Injury resulting in first aid or minor supportive medical treatment, minor system impairment.

Probability of an accident (The likelihood that an event will occur.):

Frequent - Continuously experienced. Likely to occur frequently in life of system, item, facility, etc.

Probable - Will occur frequently. Will occur several times in life of item.

Occasional - Will occur several times. Likely to occur sometime in life of item.

Remote - Unlikely, but can reasonably be expected to occur. Unlikely but possible to occur in life of item.

Improbable - Unlikely to occur, but possible. So unlikely, it can be assumed occurrence may not be experienced.

RISK ASSESSMENT MATRIX

SEVERITY	PROBABILITY OF AN ACCIDENT (E = Extremely High H=HIGH M=MODERATE L=LOW)				
	Frequent	*Probable*	*Occasional*	*Remote*	*Improbable*
Catastrophic	**E**	**E**	**H**	**H**	**M**
Critical	**E**	**H**	**H**	**M**	**L**
Marginal	**H**	**M**	**M**	**L**	**L**
Negligible	**M**	**L**	**L**	**L**	**L**

BLOCK	WORKSHEET INSTRUCTIONS (See FM 100-14 for details)
A-D	Self explanatory
E	Identify tasks related to the mission or task in block B
F	Identify hazards by reviewing factors (METT-T) for the mission or task
G	Assess hazards using risk assessment factors and risk matrix above
H	Develop one or more controls for each hazard to eliminate or reduce risks
I	Determine residual risk assessment for each hazard not eliminated
J	Enter implemented controls. Decide how each control will be in effect or communicated to the personnel who will make it happen. (Written or verbal; SOP, rehearsals, etc.)
K	Select highest residual risk level, which becomes the overall risk level
L-M	Self explanatory
	Supervise and Evaluate – Implement monitoring and reassessment actions as the situation/condition changes. Determine if controls are adequate. Improve, if necessary. Develop and share lessons learned.

25th INFANTRY DIVISION (LIGHT) and
US ARMY HAWAII

RISK MANAGEMENT CARD

Reference: FM 100-14, April 98

1. IDENTIFY HAZARDS - Identify hazards or factors that may adversely affect task accomplishment

2. ASSESS HAZARDS - Determine extent of severity and potential

3. MAKE RISK DECISION AND DEVELOP CONTROLS - Reduce risk to task essentials and establish control measures

4. IMPLEMENT CONTROLS - Perform, conduct, etc. control measures

5. SUPERVISE - Validate and ensure control measures are effective and followed

KEY DEFINITIONS

HAZARD - Actual or potential condition with the potential of causing injury to personnel, damage to equipment, or structures, loss of material, or reduction of availability to perform a prescribed function.

RISK – chance of hazard or bad consequence expression of possible loss over a specific period of time or number of operational cycles.

RISK ASSESSMENT – Identification and assessment of hazards; steps 1 and 2 of the Risk Management Process.

RESIDUAL RISK – Level of risk remaining after controls have been identified and selected for hazards that may result in loss.

DECISION FOR RESIDUAL RISK

EXTREMELY HIGH - MACOM Commander

HIGH - Corps/Division/Installation Commander

MODERATE & LOW - Delegated to Appropriate Levels

A. Receipt of mission or task:	B. Mission or Task:	C. DTG prepared:
1 August 2006	MMR Prescribed Burn	16 August 2006

D. Risk assessment prepared by: GS-11, Greenlee, Fire Management Officer, IFSO

E. Task	F. Identify Hazards	G. Assess Hazards	H. Develop Controls	I. Determine Residual Risks	J. Implement controls
Prescribed Burning	1. Unexploded Ordnance (UXO) Presence	High	Everyone will stay a minimum of 300 meters away from any open flame and/or blackened area for 24 hours or until authorized by the Safety Office. Personnel who enter High Hazard Areas (HHA) will comply with the following: - Be trained in UXO recognition and have current CPR and first aid training. - Never touch UXO or unidentified objects. - Wear flack vest and helmet if UXO present	Moderate	AR 385-63, EOD SOP, Range Division SOP, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan (Installation Fire and Safety Office will provide safety oversight of controls.)

K. Determine overall mission/task risk level after controls are implemented

LOW (L) MODERATE (M) **HIGH (H)** **EXTREMELY HIGH (E)**

L. Determine approval level:	M. Approval:
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<tr><td>Prescribed Burning</td><td>1. Unexploded Ordnance (UXO) Presence (Cont.)

2. Terrain</td><td>High

High</td><td>- Keep to the black when it is safe to do so – it is easier to identify UXO.

- Not key radios within 15 meters of known UXO

Conditions of roads, trails, and paths will be assessed and briefed prior to any movement

Stay on the alert for lose soil and vegetation. Movement through tall grass should be avoided. If movement must go through tall grass the area will be surfaced cleared by EOD.</td><td>Moderate

Moderate</td><td>AR 385-63, AR 385-10, CFR 1910.132-138, EOD SOP, Range Division SOP, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan (Installation Fire and Safety Office will provide safety oversight of controls.)

AR 385-63, AR 385-10, CFR 1910.132-138 SOPs, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan, and Briefings (Installation Fire and Safety Office will provide safety oversight of controls.)</td></tr>
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E. Task	**F. Identify Hazards**	**G. Assess Hazards**	**H.Develop Controls**	**I. Determine Residual Risks**	**J. Implement controls**
Prescribed Burning	3. Weather	High	During days of hot temperatures personnel will properly hydrate before, during, and after operations also implement work/rest plan. If weather affects visibility, personnel will not enter HHA. When rain is a possibility, personnel will take appropriate rain gear with them and wear it when appropriate. Avoid areas where rain has created mud or standing water. Avoid streambeds and low lying areas known for flash flooding during times of heavy rain.	Moderate	SOPs, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan, and Prescribed Burn Plan (Installation Fire and Safety Office will provide safety oversight of controls.)
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E. Task	**F. Identify Hazards**	**G. Assess Hazards**	**H.Develop Controls**	**I. Determine Residual Risks**	**J. Implement controls**
Prescribed Burning	3. Weather (Cont.)	High	Monitor weather conditions with hand held equipment, RAWS, local forecasts, and spot weather forecasts by National Weather Service. Stay within prescription. Post a lookout.	Moderate	AR 385-63, EOD SOP, Range Division SOP, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan, and Prescribed Burn Plan, Fluid Replacement Guidelines for Warm-Weather Training (Installation Fire and Safety Office will provide safety oversight of controls.)
	4. Vehicle Movement	Moderate	Drivers will be properly licensed and will PMCS vehicles prior to daily operations. Vehicles will only be operated on existing roads/trails and will not be operated in areas that have not been surfaced cleared. Ground guides will be used when backing vehicle and in areas of limited visibility.	Low	AR 385-55, AR 600-55, SOPs, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan (Installation Fire and Safety Office will provide safety oversight of controls.)

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E. Task	**F. Identify Hazards**	**G. Assess Hazards**	**H.Develop Controls**	**I. Determine Residual Risks**	**J. Implement controls**
Prescribed Burning	4.Vehicle Movement (Cont.)	Moderate	Vehicles will not be operated in areas that exceed the drivers experience level. (Aircraft) Pilots will be briefed and take all directions from the IC or Flight Ops Officer (within the Incident Command Team) and will maintain radio communications at all times.	Low	AR 385-55, AR 600-55, SOPs, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan (Installation Fire and Safety Office will provide safety oversight of controls.)
	5. Fire suppression	High	Escape route and safety zones will be briefed. Weather and fire conditions will be closely monitored by a designated lookout. Aerial buckets will be used for suppression in hazardous areas.	Moderate	AR 385-10, CFR 1910.132-138, Range Division SOP, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan, and Prescribed Burn Plan (Installation Fire and Safety Office will provide safety oversight of controls.)

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E. Task	**F. Identify Hazards**	**G. Assess Hazards**	**G. Develop Controls**	**I. Determine Residual Risks**	**J. Implement controls**
Prescribed Burning	5. Fire suppression (cont)	High	Chainsaws will be operated only by qualified personnel. Saw operator and swamper will wear chaps and ear protection. A briefing will be held at the start of every shift. A spot weather forecast will be ordered each day until fire is 100% contained and afterward at IC's discretion. Only trained, pack-tested, personnel will be in the fire area unless IC approves of person, such as GPS personnel, etc. The Incident Commander will have communications with everyone on the fireline.	Moderate	AR 385-10, CFR 1910.132-138, Range Division SOP, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan, and Prescribed Burn Plan (Installation Fire and Safety Office will provide safety oversight of controls.)
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<tr><td>Prescribed Burning</td><td>5. Fire suppression (cont)

6. Aerial Ignition (Plastic sphere dispenser operation) Unqualified Personnel</td><td>High

Moderate</td><td>The Incident Command system will be used. There will always be a qualified IC until the fire is 100% contained.

Proper PPE will be worn.
- Nomex Shirt & Pants or Jumpsuit
- Safety Goggles
- 8" Leather Boots
- Leather Gloves
- Hard Hat or Helmet with chin strap
- Nomex Hood
- Fire Shelter
- Flack vest and helmet if UXO present

Sphere dispenser operator shall be certified annually. Pilot and aircraft will be certified annually.</td><td>Moderate

Low</td><td>AR 385-10, CFR 1910.132-138, Range Division SOP, USARHAW Operational Guidance for Hazard Areas, USARHAW Wildland Fire Management Plan, and Prescribed Burn Plan (Installation Fire and Safety Office will provide safety oversight of controls.)

Interagency Aerial Ignition Guide (April 2001), AR 385-10, CFR 1910.132-138 (Installation Fire and Safety Office will provide safety oversight of controls.)</td></tr>
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E. Task	F. Identify Hazards	G. Assess Hazards	H.Develop Controls	I. Determine Residual Risks	J. Implement controls
	6. Aerial Ignition (Plastic sphere dispenser operation) Possible Malfunction (cont)	Moderate	Pilot will have 2 hours of fire behavior training and be trained in the use of the fire shelter and supplied with one.	Low	Interagency Aerial Ignition Guide (April 2001), AR 385-10, CFR 1910.132-138 (Installation Fire and Safety Office will provide safety oversight of controls.)
		Moderate	Bench testing will be done prior to mounting and a safe distance from aircraft. Operator & Pilot will have a fire shelter and wear PPE. 1. Nomex Flight Suit & Gloves 2. Flight Helmat 3. Boots Operator will immediately notify the pilot and take appropriate action to correct malfunction.	Low	Interagency Aerial Ignition Guide (April 2001), AR 385-10, CFR 1910.132-138 (Installation Fire and Safety Office will provide safety oversight of controls.)

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	6.Aerial Ignition (Plastic sphere dispenser operation) Possible Malfunction (cont)	High	If malfunction cannot be corrected in the air the pilot will land. If a fire occurs in the machine that the operator can not extinguish, the pilot will be notified and the machine will be jettisoned.	Moderate	Interagency Aerial Ignition Guide (April 2001), AR 385-10, CFR 1910.132-138 (Installation Fire and Safety Office will provide safety oversight of controls.)
	7. Incident Command System (ICS) Lack of Command and Control	High	Identify qualified ICS personnel by position and name. If command changes, announce change by name on radio and obtain confirmation from everyone on fireline and camp.	Moderate	NFPA 1561,Prescribed Burn Plan, USARHAW Wildland Fire Management Plan (Installation Fire and Safety Office will provide safety oversight of controls.)
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					FS-6700-7 (11/99)
US ARMY, HAWAII	**1. WORK PROJECT/ACTIVITY** Aerial Ignition – Plastic Sphere Dispenser (PSD)		**2. LOCATION** Various		**3. UNIT** R8
JOB HAZARD ANALYSIS (JHA)	**4. NAME OF ANALYST** J. Finley, US Forest Service		**5. JOB TITLE** HOS		**6. DATE PREPARED** 11/25/05

7. TASKS/PROCEDURES	8. HAZARDS	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls * PPE
*Travel to, from and on project	Motor vehicle accidents. Slippery road surfaces. Narrow roadways. Weather/darkness/ smoke	Drive defensively. Use seat belts. Identify road conditions in briefing. Post road guards when needed. Use backers and chock vehicles. Have vehicles facing out. Maintain communications. Notify law enforcement when neccesary
*Qualifications for assigned position	Lack of experience, injuries, accidents	Ensure all personnel involved in operation have maintained currency and are qualified. Reference FSH 5109.16 and Pilot/aircraft qualification card.
*Briefing	Inadequate briefing done, personnel absent from formal briefing.	Provide project briefing prior to activities with all personnel to clarifiy objectives, organizational responsibilities, communications, hazards, weather, expected fire behavior. Communications/flight following verified. Flight crew to brief on PSD operations – Reference Aerial Ignition Guide and PSD training document.
*Preflight equipment – Helicopter/Plastic Sphere Dispenser	Manager to ensure helicopter pilot has completed preflight. PSD operator to ensure ignition device is inspected and secure.	Pilot has completed helicopter preflight and load calculation form prior to operations. PSD bench tested and installed in the aircraft and is operational.
*Injuries due to heavy lifting	PSD is in shipping box and is difficult	Work area should be clear of obsticles. Forethought given to proper lifting/bending techniques. Use help

	to remove. Placement in helicopter lends itself to awkward bending/reaching	if available. Prepare for the operation by performing stretching/bending exercises.
Personal Protective Equipment (PPE)	Injuries consistant with crushing/pinching /falling/burns	Always wear required PPE and ensure others wear it also. Reference Interagency Helicopter Operations Guide (IHOG) or Aviation Life Support Equipment (ALSE)
*Helibase/Helispot Operations	Accidents or incidents	Ensure that all landing areas meet IHOG requirements – safety circle/support equipment/fire extinquisher/signs. Allow only authorized personnel on-site.
*Hazardous Materials (haz-mat)	Injuries/burns. Ingestion-Inhalation of chemicals	Identifiy and mitigate any possible haz-mat problems utilizing "Transportation of Hazardous Materials Guide". Practise safe work ethics. Avoid mixing of any on-site chemicals.
*First Aid	Injuries	Notify dispatch of any threatening injury and treat accordingly. Burn plan/Helicopter Operations plan should have other pertainent information. Remain within the scope of your training.
*Communications	Poor communications, faulty equipment	Perform radio checks with all concerned parties. Identifiy emergency procedures beforehand. Ensure additional hand-held batteries available to landing area personnel.
*Incidents/accidents	Various	Discuss incident/accident possibility and emergency proceedures in your briefings. Communicate problems with Dispatch, activate crash-rescue plan. Ensure your safety prior to any action. *"Sometimes the only action you should take is notifying dispatch that an accident has occurred"* - SAFECOM to be completed for all incidents/accidents (as soon as possible)
*Operations	Various	Follow procedures lined out in Aerial Ignition Guide and PSD training manual for general operations and machine malfunction.

*Feeling the need for speed	Mistakes made	Do not get moving so fast that your actions overun your abilty to cope. Avoid mistakes, do not hurry, Prescribed fire is not an emergency. If something happens, inform those around you and follow procedure. Maintain required currency training.

SECTION 12
FUNDING

A. Total estimated cost: $35,000 to $55,000 per burn, depending on whether the first attempt is successful (see attached worksheets).

B. Source of Funds

(x) Wildland Fire Management funds
(x) Transformation, G-7 funds

Worksheet for Estimating Costs of burn

Narrative: Army and Federal Fire crews will be engaged in the burn for a 6 hour period, plus patrol for four days

Fill in yellow squares as examples show — **Excel calculates the values in blue**

Burn Name: MMR 06-02 **Date:** 27-Sep **Burn Boss:** Jason Greenlee

GSA Rental	Type Equipment	Hourly Rate (1)	Hours Used	
	Army T4 engine	$6.63	14	$92.82
	Army T4 engine	$6.63	14	$92.82
	Army T4 engine	$6.63	6	$39.78
	Army Crew cab	$3.30	14	$46.20
	Army Crew cab	$3.30	14	$46.20
	Army Crew cab	$3.30	14	$46.20
	Army Tender	$6.63	6	$39.78
	Fed Fire Brush Engine	$8.00	6	$48.00
	Fed Fire Tender	$6.63	6	$39.78
			Equipment Sub-total	**$491.58**

Salaries	Person's Name	Hourly Rate	Overtime Rate	Hours Prep & Monitoring	Hours on Burn Day	Hours Patrol and Mop Up	Hours Basic Time	Hours Overtime	Total Hours	Total Cost
	Federal Fire GS-6	$16.83	$25.25	0.00	8.00	0.00	8.00	0.00	8.00	$134.64
	Federal Fire GS-7	$18.69	$28.04	0.00	8.00	0.00	8.00	0.00	8.00	$149.52
	Federal Fire GS-8	$20.70	$31.05	0.00	8.00	0.00	8.00	0.00	8.00	$165.60
	Federal Fire GS-9	$22.87	$34.31	0.00	8.00	0.00	8.00	0.00	8.00	$182.96
	Army Fire GS-4/1	$13.49	$20.24	0.00	8.00	8.00	29.49	16.00	32.00	$721.58
	Army Fire GS-4/1	$13.49	$20.24	0.00	8.00	8.00	16.00	16.00	32.00	$539.60
	Army Fire GS-4/1	$13.49	$20.24	0.00	8.00	0.00	8.00	16.00	24.00	$431.68
	Army Fire GS-4/1	$13.49	$20.24	0.00	8.00	0.00	8.00	16.00	24.00	$431.68
	Army Fire GS-4/1	$13.49	$20.24	0.00	8.00	0.00	8.00	16.00	24.00	$431.68
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	Army Fire GS-4/1	$13.49	$20.24	0.00	8.00	0.00	8.00	16.00	24.00	$431.68
	Army Fire GS-4/1	$13.49	$20.24	0.00	8.00	0.00	8.00	16.00	24.00	$431.68
	Army Fire GS-5/1	$15.09	$22.64	0.00	8.00	0.00	8.00	16.00	24.00	$482.88
	Army Fire GS-9/1	$22.87	$34.31	0.00	8.00	0.00	8.00	16.00	24.00	$731.84
	GS-11/7 Fire Mgt Off	$33.20	$49.80	0.00	8.00	0.00	8.00	16.00	24.00	$1,062.40
	GS-13/1 Fire Chief	$39.43	$59.15	0.00	8.00	0.00	8.00	0.00	8.00	$315.44
	GS-11/5 Safety Officer	$31.35	$47.03	0.00	8.00	0.00	8.00	16.00	24.00	$1,003.20
	GS 13/10 Rx Manager	$51.26	$76.89	0.00	8.00	0.00	8.00	16.00	24.00	$1,640.32
								Salaries Sub-total		**$10,151.74**

Equipment Expenses	Type Equipment	Type Expense	Rate/mile(1)	Miles	
	Army T3000	transportation			$6,000.00
	other		rate/mile	0	$0.00
				Equipment Sub-total	**$6,000.00**

PTA Crew	Rooms	Nights	Rate per Room	
Travel				$3,010.00
Lodging	0	0	$0.00	$0.00
			Lodging Sub-total	**$3,010.00**

Contract Helicopters	Type Equipment	Hours	Hourly Rate	
Pacific Hughes 500	Light Helicopter	6	$800.00	$4,800.00
Pacific Ranger 500	Light Helicopter	6	$950.00	$5,700.00
K&S Hughes 500	Heavy Helicopter	6	$775.00	$4,650.00
K&S Bell 407	Light Helicopter	6	$1,450.00	$8,700.00
K&S Bell 407	Light Helicopter	6	$1,450.00	$8,700.00
Windward Hughes 500	Light Helicopter	6	$1,000.00	$6,000.00
			Contracts Sub-total	**$38,550.00**

Army Helicopters (includes crew)	Type Equipment	Hours	Hourly Rate	
	Blackhawk	0	$2,000.00	$0.00
	Blackhawk	0	$2,000.00	$0.00
			Army Sub-total	**$0.00**

National Guard Helicopters (includes crew)	Type Equipment	Hours	Hourly Rate	
	Blackhawk	0	$2,800.00	$0.00
	Chinook	0	$7,500.00	$0.00
			Nat Guard Sub-total	**$0.00**

Supplies	Item Name	Price/Item	Number Units	
	Ping Pong Balls	$0.15	0	$0.00
	Glycol	$2.00	10	$0.00
	Fuel	$2.09	10	$0.00
	Meals	$5.00	180	$900.00
	Supplies			$7,287.00
	Rental of Lift			$500.00
			Supplies Sub-total	**$8,687.00**

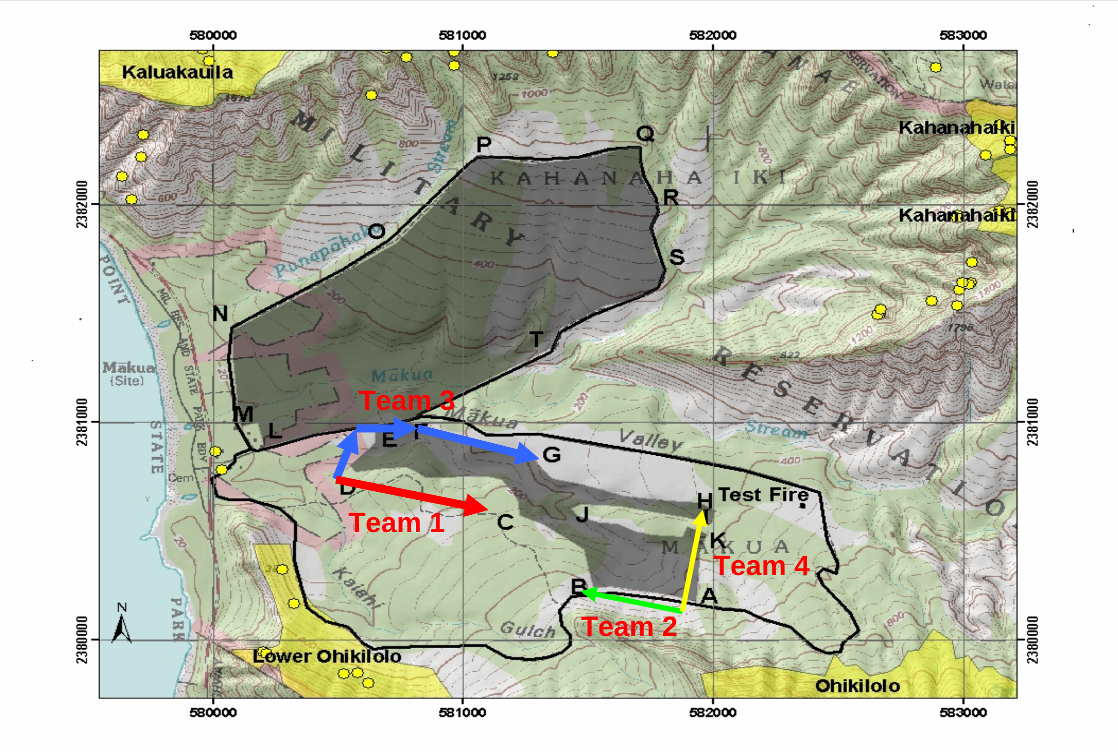
Herbicide Spraying	Acres Sprayed	Cost/ac		
Spraying	**78**	**35**		$2,730.00
Mixing				$1,970.00
			Spraying Sub-total	**$4,700.00**

Total Cost (including salaries & GSA vehicle rental)	$71,590.32
Hard Money Cost (without salaries & GSA vehicle rental)	**$60,947.00**
Total Cost/Acre (including salaries & GSA vehicle rental)	**$917.82**
Total Cost/Acre (without salaries & GSA vehicle rental)	**$781.37**

Acres Burned **78**

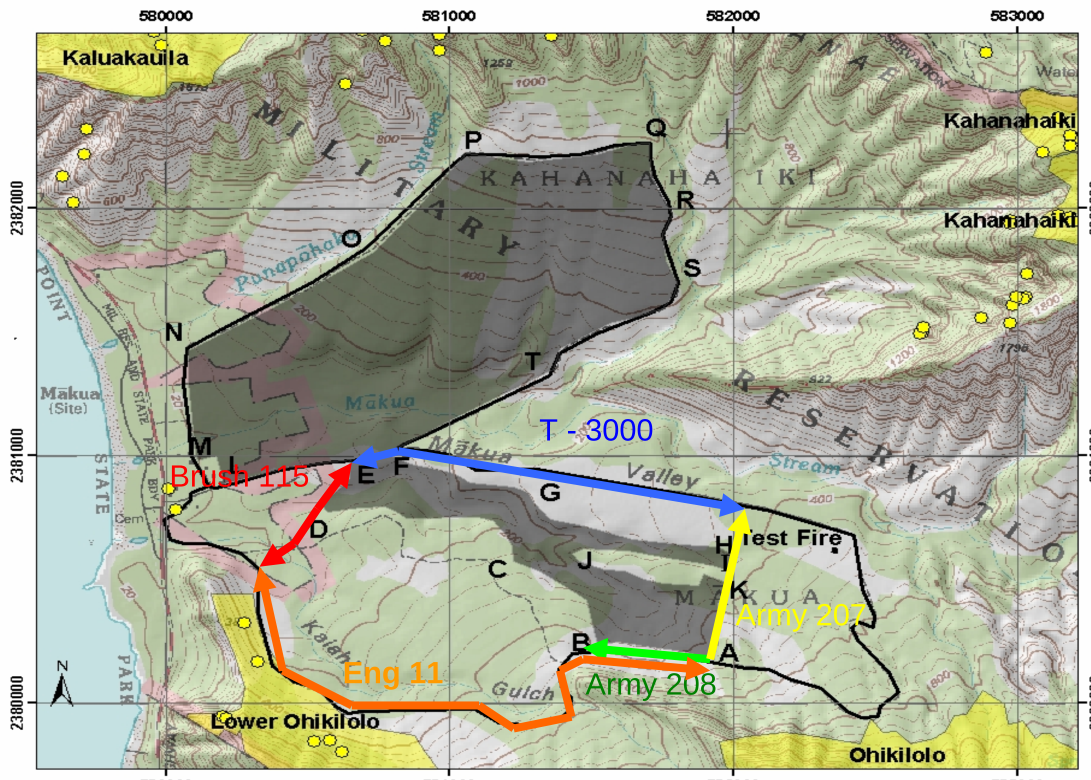
Example of an Incident Action Plan – Individual IAPs for each prescribed burn will vary.

INCIDENT BRIEFING
4. Map Sketch



Plan A: Wind from East: The wind pattern has been from the East all day for the last few days. If wind is moving from the east after briefing, Army resources, the T3000, and Brush 115 will report to **Point D for the test burn**. Engine 11 will stage at below Lower Olikilolo. The Army Environmental team may post themselves at the lookout above point B or below Lower Olikilolo with Engine 11. During and after the test burn, the T3000 will post at point E. Brush 115 shall pre-treat the fuel on the outside of the fireline at point D. Team 1 (vehicle TBD) will fire from D to B and Team 3 (with unit 274) will fire from points D to F. Team 1 cannot walk D to B, so they will be using a flare gun to ignite from D to B. If Team 1 is not successful with the flare gun, the ignition helicopter may be used to light D to B. Special care will be taken from E to F, as the fuels on both sides of the road are close. There is also dry fuel on the outside of the firebreak at point D and from points H to A, so ignite with care. Brush 115 should patrol weak areas frequently. Once F has been reached and the line from D to F is secure, the two teams will slowly pull fire along the rim from D to B and F to H. Teams will try to stay up with each other moving up the sides of the gully. The D to F road will continue to be patrolled during the entire burn by Brush 115. The T3000 may be moved from E and patrol from E to H, depending on wind strength and direction. Once C and G are reached (or at such time as the burn boss elects), firing teams 2 (with unit 224 and hummer 208 supporting) and 4 (with unit 223 and hummer 207 supporting) will move to Point A. Point A contains a dangerous dog-leg that will be carefully and slowly burned out before proceeding. Team 2 will burn from points A to B, and Team 4 will burn from A to H. The UH-1H will support this phase of the operation by wetting A-H and A-B on the far side of the firebreak road. Sequences for the last phases of the burn, which is to complete the perimeter and interior burning, will depend on progress on the perimeter and ability of the fire to move into the interior without assistance.

Plan B: Wind from West: It is possible that we could get a wind from the west during the burn. If so, the burn sequence is reversed. The Army's crewcabs and Hummers and Brush 115 will stage at point A. Engine 11 and Army Environmental crew will stage below the rare species habitat on the road below Lower Ohikilolo for the **test burn at point A**. The T3000 will be manned by Federal Fire personnel (TBD) will stage at H. A hose lay has been put down from A to H to be connected Brush 115. Team 2 (unit 224), with Hummer 208, will start lighting from points A to B and Team 4 (unit 223), with Hummer 207, will start at the same time from points A to H. On successful completion of this burn-out, Teams 1 and 3 will start a burnout from Points D to F (Hummer 274). Teams 2 and 4 will stay with Hummers 207 and 208 to monitor points B to H. The T3000 willl patrol from H to F. Team 1 will start the west burn-out moving from D to B and Team 3 will burn from D to F. Team 1 cannot walk D to B, so they will be using a flare gun to ignite from D to B. Or the ignition helicopter may be used to light D to B if Team 1 is unsuccessful.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T - 3000
Brush 115
Test Fire
Army 207
Eng 11
Army 208
Makua Valley
Lower Ohikilolo
Ohikilolo
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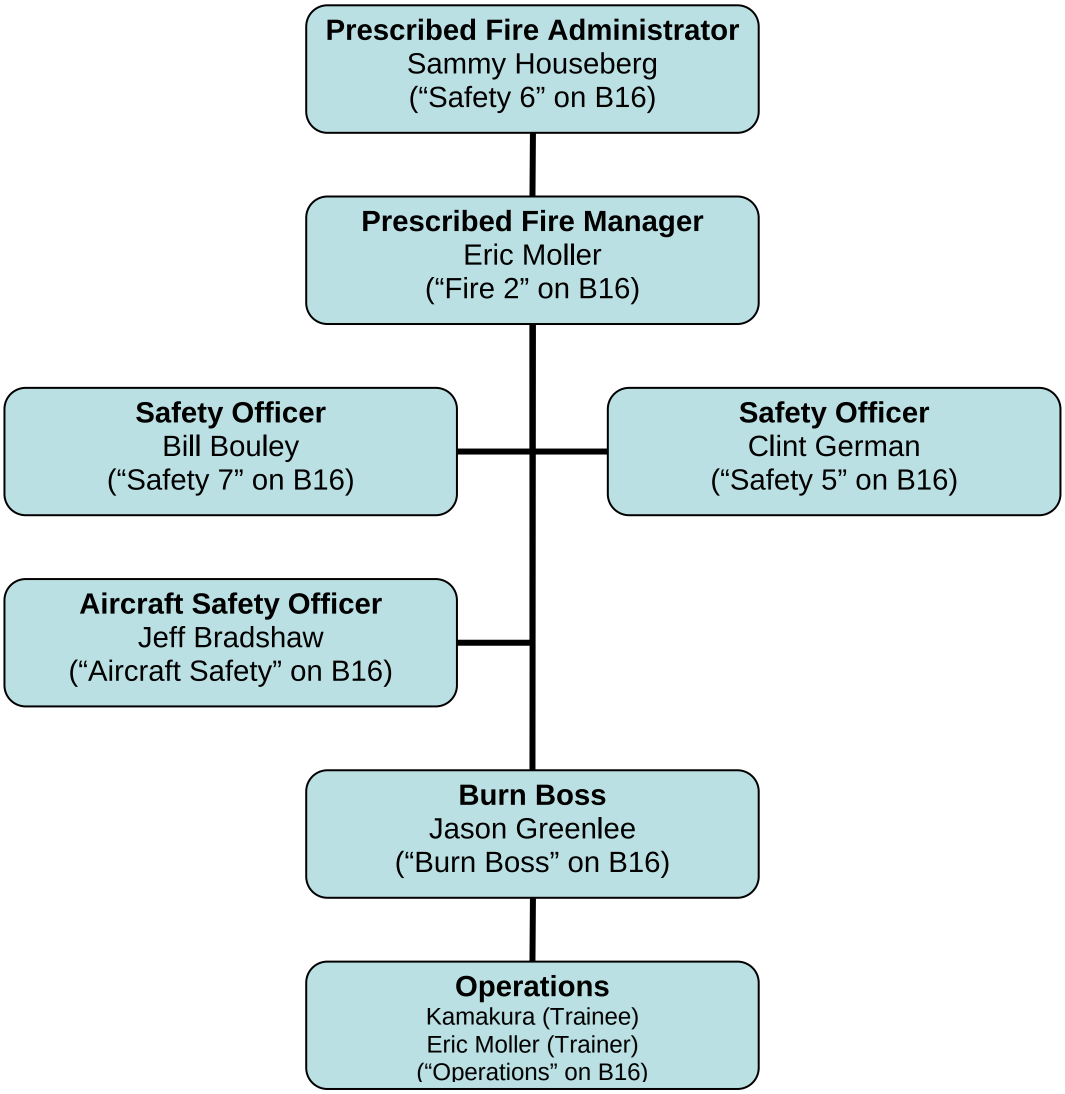
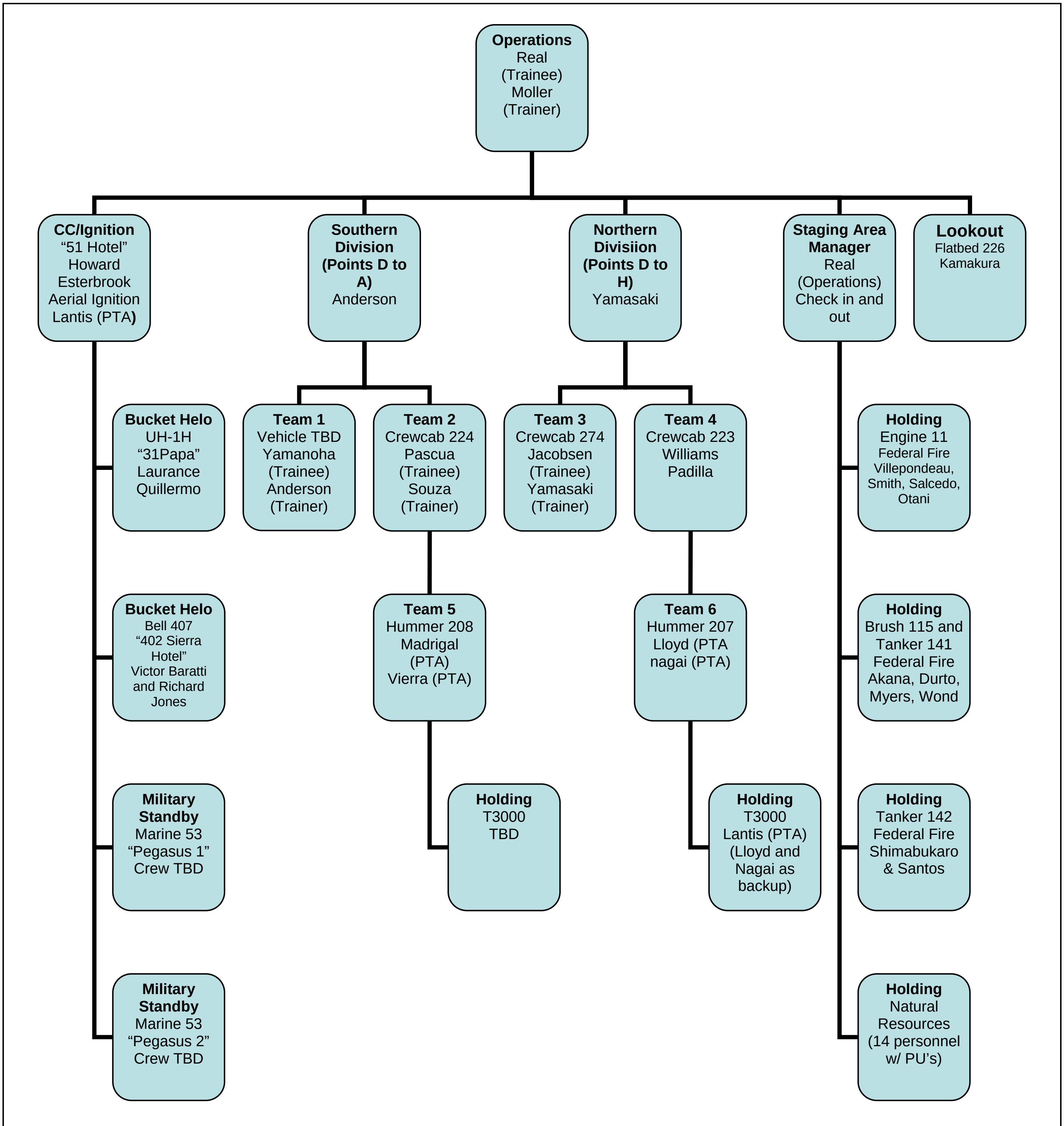
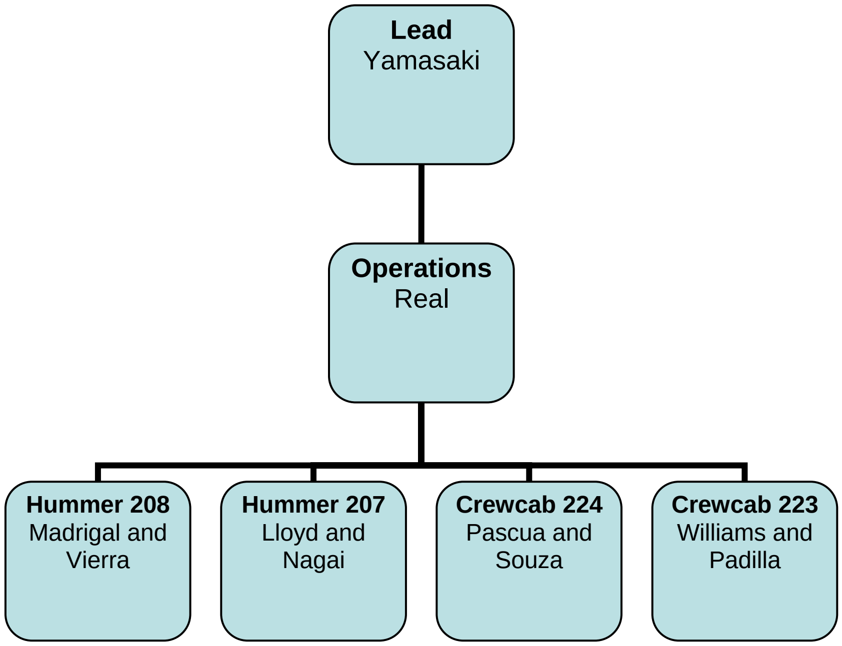


Page 1 of 3	6. Prepared by (Name and Position) Jason Greenlee, Fire Management Officer

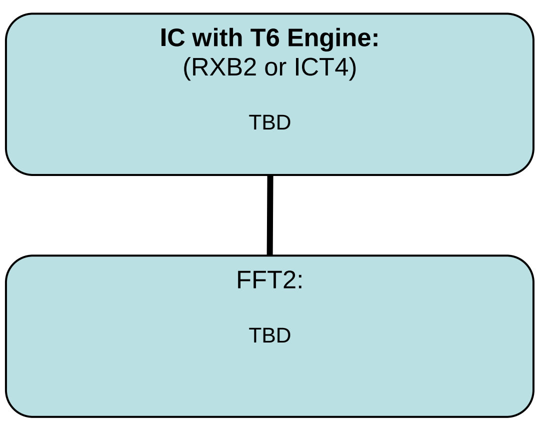


Page 2 of 3	6. Prepared by (Name and Position) Jason Greenlee, Fire Management Officer

MOP UP ORGANIZATION



PATROL ORGANIZATION



Page 3 of 3	6. Prepared by (Name and Position) Jason Greenlee, Fire Management Officer

6. Resources Summary				
Resources Ordered	Resource Identification	ETA	On Scene	Location/Assignment
2 Army brush engines	Army 207 and 208	0600		Ignition/holding/lookouts
10 person Army handcrew plus 3 crewcabs	Army wildfire crew	0600		Ignition/holding/lookouts
The following from Federal Fire: 1 Type 6 brush engine, 1Type 4 fire engine, and 2 tankers	Brush 115, Engine 11, Tanker 141, Tanker 142	0600		Holding
Pacific Bell Ranger 206 Howard Estebrook	"51Hotel"	0700		Command and aerial ignition operations
Pacific Hughes UH-1H Laurance Quillermo	"31 Papa"	0700		Holding
K&S Bell 407 Victor Baratti and Richard Jones	"402 Sierra Hotel"	0700		Holding
Natural Resources hand crew (4)	"Kilo", "Romeo", "Foxtrot" and "Hotel"	0600		Holding
Pacific Helicopters fuel tender	"Fuel tender"	0600		Helicopter fueling
2 Marine 53 helicopters (on standby at MC base)	"Pegasus 1" and "Pegasus 2"	0600		Holding/contingency
3 Army safety officers	"Safety 5" "Air Safety" "Safety 7"	0600		Safety
PTA personnel (5 +Chief Moller)	Various call signs – see commo plan attached	0600		Ignition/Holding

7. Summary of Current Actions

0600, personnel arrive, check in with Operations, and prepare equipment for burn
0700, briefing at Command Post
0700, Helicopters arrive, pilots briefed, Pacific Helicopters UH-1H may apply retardant to any areas indicated by burn boss
0730, preparation and final checks of equipment, pre-position holding resources.
0730, ready to ignite test burn at D or A (to be determined at briefing).
0730, ignition begins
0830-0900, new Fed Fire shift arrives for transition, operations gives new shift briefing
1300, ignition ends, patrol and mop-up begins.

Page 1 of 1	Prepared by: Jason Greenlee, RxB2, Fire Management Officer

MEDICAL PLAN	1. Incident Name **Makua Burn**	2. Date Prepared **October 20, 2006**	3. Time Prepared **1600**	4. Operational Period

5. Incident Medical Aid Station

Medical Aid Stations	Location	Paramedics Yes	Paramedics No
On site first aid	**On site**	**x**	
Waianae Comprehensive Health Cnt.	**86-260 Farrington Highway Waianae 696-1499**	**x**	
City and County of Honolulu	**Waianae Comprehensive Health Cnt.**		**x**
		☐	☐
		☐	☐

6. Transportation

A. Ambulance Services

Name	Address	Phone	Paramedics Yes	Paramedics No
Waianae Fire Dept	**Farrington Highway Waianae**	**911**	**x**	☐
				☐
			☐	☐
			☐	☐
			☐	☐

B. Incident Ambulances

Name	Location	Paramedics Yes	Paramedics No
None on scene	**N/A**	**N/A**	☐

7. Hospitals

Name	Address	Travel Time Air	Travel Time Grnd	Phone	Helipad Yes	Helipad No	Burn Center Yes	Burn Center No
					X	☐	☐	**X**
St. Francis West	**91-2141 ft. Weaver Road**	**15**	**25**	**547-6011**	**X**	☐	☐	**X**
Struab	**King Street, Honolulu**	**15**	**30**	**522-4000**	**X**	☐	**x**	☐
		☐	☐		☐	☐	☐	☐

8. Medical Emergency Procedures

No ambulance on site. Treatment on site at Command Post for minor injuries by firefighter/EMTs. Immediately call 911 for any serious or life-threatening emergencies and ambulatory transport. MEDEVAC available through Range Control Dispatch Center.

9. Prepared by (Medical Unit Leader)	10. Reviewed by (Safety Officer)

Final Operational Briefing

To be completed by the Burn Boss at the burn site prior to beginning of each shift or when the hazards change due to a change in work site location or other conditions.

Names, introductions, fill in organization chart **Commander's Intent (Mr. Houseberg)** **Boundary locations/types** **Fuels, slopes, aspects near boundaries that would contribute to escape of fire** **Terrain influences** **Expected weather** **Expected fire behavior** **Organization** **- responsibilities, qualifications.** **- Specific tactical assignments** **Communications for the burn and for an escape** **- Use channel B16** **- Radio test** **- If you see a spot, notify burn boss** **- Air/ground radios with lookouts (1), Jeff (1), range (1), PSDO operator (1). Chargers are available.** **Water/retardant drops completed** **Areas to exclude from the burn** **- Rare and endangered species** **- Maps, control points, Maximum Allowable Area** **Tactics/firing/hold/patrol** **GO SLOW WITH IGNITION** **Logistics – transportation, supplies, and equipment** **Lookouts** **- LCES radio checks each hour** **- Weather recorded** **- record radio trans with time** **- Record fire rate of spread** **- Record helicopter productivity if available** **- A person to check the amount and direction of smoke** **Equipment** **– in place/checked/fired up?** **- Locations for water re-supply** **- forklift/retardant operation** **- Give shelters to helicopter crew** **- Keys in rigs** **- Shift change for Fed Fire at 0900** **- notify Ops when you move your vehicles** **Mitigation of risks and hazards** **- Special considerations, hazards and risks (read at least one JHA)**	**CHECK IN/OUT WITH STAGING MGR** **Safety** **- Explosives (Bill)** **- Pigs** **- LCES CHECKS** **Do not abuse range control** **Sign in and out each day** **Use portapoties** **Don't go into office** **Helicopter plan: CHANGES WITH FUEL/STANDBY** **- Special: Pilot wet which areas for his bucket check** **- Backup with 53's** **- we can't start until UH-1H test buckets and Tom is in air with bucket** **- Be sure you always have one hour's fuel** **- 2 wind socks are at B and G** **- Crash kits and extinguishers are available** **Smoke sensitive targets and mitigate** **Go through GO-NO-GO list** **Contingency plans** **- only Mr. Houseberg declares escape** **- sirens will sound if escape** **- ENGINES: watch for spots, do not attack** **– Trigger points for disengagement** **– What to do if fire spots over line** **– What to do if fire declared an escape** **– Escape routes, safety zones** **– Medivac plan** **– Resources working nearby** **– Resources of air support available if needed** **Everyone comfortable with assignments?** **Questions or concerns?** **DOES EVERYBODY HAVE EVERYTHING THEY NEED?** **Radio check DOES EVERYONE HAVE RADIO?**

LCES Radio Check
Date: ___________

Last Name	Time	Time	Time	Time	Time	Time	Time	Time	Time

Helicopter Performance
Date: ___________

Tail Number	Chains	Chains	Chains	Chains	Chains	Chains	Chains	Chains	Chains

Go-No-Go Checklist – required DAILY

A. Is the Administrator Go-No-Go Pre-Ignition Checklist completed? If NO STOP.
B. Has the burn unit experienced unusual drought conditions or contain above normal fuel loadings which were not considered in the prescription development? If NO proceed with checklist. If YES go to item B.
C. If YES have appropriate changes been made to the ignition and holding plan and the mop up and patrol lines? If NO STOP.

A. BURNING OPERATIONS	**YES or N/A**	**NO (STOP)**
1. Have you checked yesterday's burn area, if applicable?	______	______
2. Is a copy of the approved plan on site?	______	______
3. If a substantial time has elapsed since the plan was written, has the plan been reviewed for any needed enhancements to meet objectives or safety requirements?	______	______
4. If any plan changes have been made, has the Burn Director signed the plan's signature sheet a second time?	______	______
5. Can the burn be executed according to plan and will it meet management objectives?	______	______
6. Is the general fire weather forecast favorable? Severe Fire Behavior potential chart checked?	______	______
7. Has a spot weather forecast been obtained?	______	______
8. Has all pre-work, i.e. hand lines etc., been completed and have the lines been inspected immediately prior to the burn?	______	______
9. Has the crew familiarized themselves with the area?	______	______
10. Are all fire prescription criteria met?	______	______
11. Has the burn boss checked the Severe Fire Behavior Potential?	______	______
12. Are all required personnel listed on the plan on site and qualified?	______	______
Has the burn boss checked the red cards of off-site personnel?	______	______
13. Are all work capacity tests and red cards up to date?	______	______
14. Have notifications been made, including dispatch?	______	______
15. Have warning signs been put out?	______	______
16. Have all personnel been briefed on objectives, operations and safety?	______	______
17. Is LCES in place and was it part of the briefing?	______	______
18. Were JHA's and special hazards discussed as part of the briefing?	______	______
19. Is all of the required equipment in place and test-started?	______	______
20. Are sufficient backup resources available for containment of escapes and has the availability of these resources been confirmed today?	______	______
21. If this is a High Complexity burn, or if one of the safety elements in the Complexity analysis is High, do you have a qualified Safety Officer on the burn?	______	______
22. Is this a multi-day burn? If so, are briefings, test fires, and go-no-go decisions planned for each day?	______	______
23. Has a test fire been conducted and documented?	______	______
24. Are all smoke management requirements met?	______	______
25. Has a radio check been done?	______	______
C. HELICOPTER OPERATIONS:		
26. Have all aviation safety requirements been met?	______	______
27. Have aerial hazards been noted?	______	______
28. Have pilots been appraised of unavoidable flight hazards?	______	______
29. Have over-flights been avoided and ground personnel placed away from flight paths?	______	______
30. Have wind socks and fire equipment been put out at LZ's	______	______

IF ALL QUESTIONS HAVE BEEN ANSWERED YES or N/A (Not Applicable), PROCEED

CERTIFIED BY:________________________________DATE:____________

TITLE: ____

Test burn and weather observations

	Prescrip tion	General Forecast On Day of Burn	Spot Weather Forecast	Test Fire Conditions	Obs Time: _______	Obs Time: ______	Obs Time: ______	Obs Time: ______	Obs Time: ______	Obs Time: ______	Obs Time: ______	Obs Time: ______
DATE/TIME												
FUEL MODELS (FBPS)												
1 HR FUELS %												
10 HR FUELS %												
LIVE FUEL MOISTURE (herb) %												
LIVE FUEL MOISTURE (woody) %												
TEMPERATURE (F)												
RELATIVE HUMIDITY %												
20 ft WIND (mph)												
20 ft WIND DIRECTION												
MIDFLAME WIND SPEED (mph)												
MIDFLAME WIND SPEED DIRECTION												
TRANSPORT WIND SPEED (m/s)												
TRANSPORT W/S DIRECTION												
MIXING HEIGHT (m)												
SMOKE DISPERSION												
BURN INDEX												
IGNITION PROB %												
DAYS SINCE RAIN												
AMOUNT (inches)												
FIRING TECHNIQUE												
IGNITION METHOD												
FLAME LENGTH (ft)												
RATE OF SPREAD (chs/hr)												

INCIDENT RADIO COMMUNICATIONS PLAN	1. Incident Name MMR 06-03	2. Date/Time Prepared 10/20 1502	3. Operational Period Date/Time Dec 6, 2006

4. Basic Radio Channel Utilization

Radio Type/Cache	Channel	Function	Frequency/Tone	Assignment	Remarks
ICOM		Hughes UH-1H	122.925	Laurance Quillermo	Call sign “31 Papa”
ICOM		Bell Ranger 206	122.925	Howard Estebrook	Call sign “51 Hotel”
ICOM		Bell Ranger 206	122.925	Victor Baratti and Richard Jones	Call sign “402 Sierra Hotel”
PACMERS	B16	Fire Administrator		Mr. Houseberg	Call sign “Safety 6”
PACMERS	B16	Fire Manager		Eric Moller	Call sign “Fire 1”
PACMERS	B16	Burn Boss		Jason Greenlee	Call sign “Fire 3”

5. Prepared by (Communications Unit)

Jason Greenlee, Fire Management Officer, GS-11

INCIDENT RADIO COMMUNICATIONS PLAN	1. Incident Name MMR 06-03	2. Date/Time Prepared 10/20 1502	3. Operational Period Date/Time Dec 6, 2006

4. Basic Radio Channel Utilization

Radio Type/Cache	Channel	Function	Frequency/Tone	Assignment	Remarks
PACMERS	**B16**	**Incident Commander**		**TBD**	**Call sign TBD**
PACMERS	**B16**	**Fed Fire Brush 115**		**Akana, Durto, Myers Wond**	**Call sign TBD**
PACMERS	**B16**	**Fed Fire Engine 11**		**Villepondeau, Smith, Salcedo, Otani**	**Call sign TBD**
PACMERS	**B16**	**Fed Fire Tanker 141**		**Akana, Durto, Myers, Wond**	**Call sign TBD**
PACMERS	**B16**	**Operations**		**Robert Real**	**Call sign “Operations”**
PACMERS	**B16**	**Lookout**		**Brice Kamakura**	**Call sign “Lookout”**
PACMERS	**B16**	**Safety**		**Clint German**	**Call sign “Safety 5”**

5. Prepared by (Communications Unit)
Jason Greenlee, Fire Management Officer, GS-11

INCIDENT RADIO COMMUNICATIONS PLAN	1. Incident Name MMR 06-03	2. Date/Time Prepared 10/20 1502	3. Operational Period Date/Time Dec 6, 2006

4. Basic Radio Channel Utilization

Radio Type/Cache	Channel	Function	Frequency/Tone	Assignment	Remarks
PACMERS	B16	UXO Safety		Bill Bouley	Call sign "Safety 7"
PACMERS	B16	Aircraft Safety		Jeff Bradshaw	Call sign "Aircraft Safety"
PACMERS	B16	Ignition Team 1 w/ vehicle TBD		Kimo Yamanoha	Call sign "Team 1"
PACMERS	B16	Ignition Team 2 Army w/ Crewcab 224		Calvin Pascua	Call sign "Team 2"
PACMERS	B16	Ignition Team 3 w/ Crewcab 274		Apu Jacobsen	Call sign "Team 3"
PACMERS	B16	Ignition Team 4 w/ Crewcab 223		Kenny Williams	Call sign "Team 4"
ICOM		PSDO Operator	122.925	Mark Lantis	Call sign "PSDO"

5. Prepared by (Communications Unit) Jason Greenlee, Fire Management Officer, GS-11

INCIDENT RADIO COMMUNICATIONS PLAN	1. Incident Name MMR 06-03	2. Date/Time Prepared 10/20 1502	3. Operational Period Date/Time Dec 6, 2006		
4. Basic Radio Channel Utilization					
Radio Type/Cache	Channel	Function	Frequency/Tone	Assignment	Remarks
ICOM		Marine helicopter	122.925	Contingency	Call sign "Pegasus 1"
ICOM		Marine helicopter	122.925	Contingency	Call sign "Pagasus 2"
PACMERS	B16	Ignition/Holding Hummer 208		Madrigal and Vierra	Call sign "Hummer 208"
PACMERS	B16	Ignition/Holding Hummer 207		Lloyd and Nagai	Call sign "Hummer 207"
PACMERS	B16	T3000		TBD	Call sign "T3000"
PACMERS	B16	Fed Fire Tanker 142		Shimabukaro and Santos	Call sign "Tanker 142"
PACMERS	B16	Army Environmental Team		Daniel Forman, Kapua Kawelo, Joby Roher, Susan Ching	Call signs Kapua "Kilo" Joby "Romeo" Dan "Foxtrot" Susan "Hotel"
5. Prepared by (Communications Unit) Jason Greenlee, Fire Management Officer, GS-11					

PSD Aerial Ignition Preplanning Checklist

Provision	Yes	No	NA
Prescribed Burn Plan approved	☐	☐	☐
Aviation Safety Plan approved	☐	☐	☐
Burn Blocks prepared for aerial ignition	☐	☐	☐
Is there an aircraft and pilot available/carded	☐	☐	☐
Aircraft and fuel truck reserved/scheduled the week before	☐	☐	☐
PSD equipment serviced and ready	☐	☐	☐
PPE, including fire shelters for all participants	☐	☐	☐
Adapters needed/available	☐	☐	☐
Extra spheres available/location	☐	☐	☐
Backup/spare PSD	☐	☐	☐
Crisis rescue/evacuation equipment ready	☐	☐	☐
Helispots prepared and approved	☐	☐	☐
Fire suppression needs available	☐	☐	☐
Enough qualified people available	☐	☐	☐
PSD Operator(s)	☐	☐	☐
Helicopter Manager(s)	☐	☐	☐
Helibase Manager(s)	☐	☐	☐
Parking Tender(s)	☐	☐	☐
Fire Protection Group	☐	☐	☐
Additional Reminders			
____________________	☐	☐	☐
____________________	☐	☐	☐
____________________	☐	☐	☐

SECTION 14

Prescribed Fire Plan Technical Review
Burn Name: MMR 06-03
Reviewer: ____________________Date:_________

Element[1]	Present	Comments
Signature page		
Criteria for review and approval of plans		
Criteria for approval of change		
Burn type (Type 1, 2, or 3)		
Burn unit description		
-location		
-size		
-elevation		
-boundaries		
-topography		
-vegetation type(s)		
Vicinity and unit maps. Detailed maps must be provided which show		
a. project boundary		
b. areas outside the unit which could potentially be affected by an escaped fire (interface, bridges, towers, etc.)		
c. potential hazards		
d. water sources		
e. escape routes and safety zones		

Purpose		
Measurable objectives		
Costs estimate		
Burn organization		
- list of personnel and qualifications		
- organization chart		
- equipment list		
- contingency resources		
Schedule		
Pre-burn or site preparation considerations		
-does plan commit to spot weather forecasts if Moderate Complexity or higher?		
-are test fire procedures described		
-does plan describe signs to be placed, lines to be prepared, permits to be obtained		
Prescription – are all elements present and reasonable?		
Provisions for weather forecasts/checks		
Ignition plan – firing techniques, ignition method, pattern		
Holding plan – number, kind, position of resources		
Water supply		
Fire Escape Contingency Plan		
a. map of Maximum Manageable Area		
b. alternative trigger points for declaring an escape		
c. the plan must state who declares an escape		
c. the plan must specify who is to be notified		
d. the plan must state that the following documentation will be started		
1. time of escape declaration		

2. who was notified		
3. environmental conditions		
4. fire/weather observations		
5. actions prior to and after escape (chronology of events)		
6. unit logs and individual statements		
7. weather forecasts		
8. spot weather forecasts		
9. data from the nearest weather station		
e. what resources will be ordered		
f. what operations will be initiated		
g. how transition of command to an IC will be triggered		
- identifies other possible but unlikely events		
- identifies contingency resources for each event		
Smoke management plan		
- identifies sensitive receptors		
- mitigation strategies		
- map of acceptable smoke drift area		
Communication plan		
- notifications to be made prior to ignition		
- notifications to be made if an escape is declared		
- radio frequencies for burning and for escape		
Inter- and intra-agency cooperation		
Monitoring and evaluation		
- pre-burn - plan should describe		
- burn day - plan should describe		

- post-burn – plan should describe		
Personnel and public safety		
- unique safety hazards		
- LCES will be in place prior to ignition and covered in briefing. Plan must state this.		
- if the burn is classified High Complexity, or if one element of the Safety element of the complexity rating is High, is a Safety Officer assigned?		
- states that a briefing will be given each shift		
Rehabilitation plan – what, who, when		
Documentation that accompanies plan		
- BEHAVE runs provided and checked by qualified persons[2]		
- spot weather records[3]		
- JHA's must be attached		
- briefing worksheet[4]		
- signature lines on briefing worksheet		
- go-no-go worksheet		
- signature lines on the go-no-go worksheet		
- worksheet for recording conditions on test burn		
- weather/fire behavior/smoke behavior worksheet[5]		
- cost worksheet		
- day of burn notification form		
- complexity rating worksheet		

Signed: ____ Date: _________________

[5] Regularly scheduled onsite weather observations are required on site prior to ignition, during implementation and after the burn until declared out on High Complexity burns and are encouraged for Low and Moderate Complexity burns, especially multi-day burns (memorandum 3/2/04, Acting Chief, Branch of Fire Management).

Purpose	x	
Measurable objectives	x	
Costs estimate	x	
Burn organization		
- list of personnel and qualifications	x	
- organization chart	x	
- equipment list	x	
- contingency resources	x	
Schedule	x	
Pre-burn or site preparation considerations		
-does plan commit to spot weather forecasts if Moderate Complexity or higher?	x	
-are test fire procedures described	x	
-does plan describe signs to be placed, lines to be prepared, permits to be obtained	x	
Prescription – are all elements present and reasonable?	x	
Provisions for weather forecasts/checks	x	
Ignition plan – firing techniques, ignition method, pattern	x	
Holding plan – number, kind, position of resources	x	
Water supply	x	
Fire Escape Contingency Plan		
h. map of Maximum Manageable Area	x	
i. alternative trigger points for declaring an escape		
c. the plan must state who declares an escape	x	
j. the plan must specify who is to be notified	x	
k. the plan must state that the following documentation will be started		
1. time of escape declaration	x	

2. who was notified	x	
3. environmental conditions	x	
4. fire/weather observations	x	
5. actions prior to and after escape (chronology of events)	x	
6. unit logs and individual statements	x	
7. weather forecasts	x	
8. spot weather forecasts	x	
9. data from the nearest weather station	x	
l. what resources will be ordered	x	
m. what operations will be initiated	x	
n. how transition of command to an IC will be triggered	x	
- identifies other possible but unlikely events		
- identifies contingency resources for each event		
Smoke management plan		
- identifies sensitive receptors	x	
- mitigation strategies	x	
- map of acceptable smoke drift area		
Communication plan		
- notifications to be made prior to ignition	x	
- notifications to be made if an escape is declared	x	
- radio frequencies for burning and for escape	x	
Inter- and intra-agency cooperation	x	
Monitoring and evaluation		
- pre-burn - plan should describe	x	
- burn day - plan should describe	x	

- post-burn – plan should describe	x	
Personnel and public safety		
- unique safety hazards	x	
- LCES will be in place prior to ignition and covered in briefing. Plan must state this.		
- if the burn is classified High Complexity, or if one element of the Safety element of the complexity rating is High, is a Safety Officer assigned?	n/a	
- states that a briefing will be given each shift	x	
Rehabilitation plan – what, who, when		
Documentation that accompanies plan		
- BEHAVE runs provided and checked by qualified persons[6]	x	
- spot weather records[7]	x	
- JHA's must be attached	x	
- briefing worksheet[8]	x	
- signature lines on briefing worksheet	x	
- go-no-go worksheet	x	
- signature lines on the go-no-go worksheet	x	
- worksheet for recording conditions on test burn	x	
- weather/fire behavior/smoke behavior worksheet[9]	x	
- cost worksheet	x	
- day of burn notification form	x	
- complexity rating worksheet	x	

Signed: ______________________________________ Date: ________________

[9] Regularly scheduled onsite weather observations are required on site prior to ignition, during implementation and after the burn until declared out on High Complexity burns and are encouraged for Low and Moderate Complexity burns, especially multi-day burns (memorandum 3/2/04, Acting Chief, Branch of Fire Management).

RECORD OF ENVIRONMENTAL CONSIDERATION (REC)

TO: Directorate of Public Works
ATTN: Environmental Division (APVG-GWV)
U.S. Army Garrison, Hawaii
Schofield Barracks, HI 96857-5013 (Stop 253)
Phone: 656-2878, ext. 1051, Fax: 656-2878

DATE: 11 December, 2006

REC CHECKLIST (Check before submitting)	
x	**Detailed Project Description**
x	**Location Map and Plans**
x	**Date of Proposed Action**
x	**Reason for Categorical Exclusion**
x	**Impact Analysis Checklist**

FROM: Installation Fire and Safety Office
Attn: Eric Moller, Acting Fire Chief
815 Wright Avenue, Bldg 108
Wheeler AAF, Hawaii

1. PROJECT TITLE: Prescribed Burn, Makua Military Reservation

2. DESCRIPTION OF PROPOSED ACTION ***(Provide detailed description of the proposed action. Attach location map and site plan, or other information that will help to clearly describe the proposal)***:

The Installation Fire and Safety Office will conduct prescribed burns at Makua Military Reservation scheduled between October, 2007, to May, 2037, depending on weather. Execution of this prescribed burn is required to reduce fuel hazards subject to potential wildfires, enhance ground visibility essential to conduct UXO surface clearance, and provide excellent ground visibility essential prior to conducting required cultural surveys. Helicopters will be used for herbicide and ignition operations. See attached Prescribed Burn Plan for detailed description of proposed action.

3. DATE OR DURATION OF PROPOSED ACTION: October, 2007 to May, 2037

4. IT HAS BEEN DETERMINED THAT THIS ACTION ***(Choose one)***:

☑ a. Is adequately covered in the following EA/EIS ***(Provide title and date of document)***:
Prescribed Burn at Makua Military Reservation, Island of Oahu, August 2002

☐ b. Is categorically excluded under Appendix B, Section II, paragraph _____ of 32 CFR Part 651 for the following reason ***(See 32 CFR Part 651, Environmental Analysis of Army Actions, 29 Mar 02)***:

5. POTENTIAL IMPACTS ON THE QUALITY OF THE ENVIRONMENT HAVE BEEN CONSIDERED AND ARE DOCUMENTED ON THE ATTACHED ENVIRONMENTAL CHEKLIST ***(Complete Environmental Impact Analysis Checklist)***. IT HAS BEEN CONCLUDED THAT THIS ACTION IS NOT SEGMENTED AND NO EXTRAORDINARY CIRCUMSTANCES EXIST THAT WOULD PRECULDE THE USE OF THE APPLICABLE CATEGORICAL EXCLUSION IDENTIFIED IN PARAGRAPH 4.b. ABOVE ***(See Section 651.29 of 32 CFR, Part 651)***.

6. THIS REC DOES NOT RELIEVE THE PROPONENT FROM COMPLIANCE WITH OTHER APPLICABLE FEDERAL, STATE AND LOCAL ENVIRONMENTAL LAWS AND REGULATIONS; I.E. NATIONAL HISTORIC PRESERVATION ACT, ENDANGERED SPECIES ACT, CLEAN WATER ACT, ETC. ***(Contact DPW Environmental Division for assistance on requirements)***.

7. THIS ACTION HAS BEEN COORDINATED WITH THE FOLLOWING OFFICES/AGENCIES:

DPW Environmental Natural Resources, Cultural, Conservation, and Compliance Branch; Fire & Safety Office; G3/DPTM Range Division; G7 Transformation; Public Affairs Office; Federal Fire Department.

SUBMITTED BY THE PROPONENT:

11 December, 2006

Jason Greenlee, Fire Management Officer

656-1331/656-3740

REVIEW AND CONCURRENCES ***(For Environmental Division use)***:

		YES	WITH CMNT	NO	
☐	(Natural Resources Program)	☐	☐	☐	(Date)
☐	(Cultural Resources Program)	☐	☐	☐	(Date)
☐	(Installation Restoration Program)	☐	☐	☐	(Date)
☐	(Water Quality Program)	☐	☐	☐	(Date)
☐	(Air Quality Program)	☐	☐	☐	(Date)
☐	(Toxic Substances Control Act Program)	☐	☐	☐	(Date)
☐	(Other environmental staff as required)	☐	☐	☐	(Date)

APPROVED BY:

(Environmental Coordinator)

(Date)

PROPOSED ACTION: ____

ENVIRONMENTAL IMPACT ANALYSIS ***(Consider both construction and operational impacts. Any "YES" or "MAY" answers need to be explained in the "Discussion" section at the end of this checklist.)***	**YES**	**NO**	**MAY**
1. <u>AIR QUALITY</u>			
a. Will the proposal cause air emissions such as smoke, dust, suspended particles, or air pollutants during construction or operations?	X	☐	☐
2. <u>WATER QUALITY</u>			
a. Is there potential for accidental spills of hazardous or toxic substances?	☐	X	☐
3. <u>TOPOGRAPHY AND SOILS</u>			
a. Will there be alterations to topography, i.e. site grading that could potentially increase soil erosion?	☐	X	☐
b. Will the construction area involve disturbance of one acre or more?	☐	X	☐
4. <u>NATURAL RESOURCES</u>			
a. Will the proposal affect undeveloped areas, endangered or threatened species, or plant or animal critical habitat?	☐	☐	X
5. <u>ARCHAEOLOGICAL/HISTORIC RESOURCES</u>			
a. Will the proposal alter or destroy any archeological sites or buildings that are over 50 years old?	☐	X	☐
b. Will the proposal require any excavation, trenching, or grading activity?	☐	X	☐
6. <u>LAND USE</u>			
a. Will the proposal alter the present land use of an area?	☐	X	☐
7. <u>HAZARDOUS MATERIALS/WASTE OR TOXIC SUBSTANCES DISPOSAL</u>			
a. Will the proposal result in alteration or disposal of existing facilities?	☐	X	☐
b. Will the proposal result in the use, treatment, storage, and/or disposal of hazardous materials or wastes?	☐	X	☐
8. <u>NOISE ENVIRONMENT</u>			
a. Will there be any changes to the numbers, types, and operations of aircraft, vehicles, or weapon systems that could effect noise levels?	☐	X	☐
9. <u>TRAFFIC</u>			
a. Will the proposal generate or increase vehicular traffic?	☐	X	☐
b. Will there be a requirement to construct, reroute or alter roadways?	☐	X	☐
10. <u>UTILITIES SYSTEMS</u>			

ENVIRONMENTAL IMPACT ANALYSIS ***(Consider both construction and operational impacts. Any "YES" or "MAY" answers need to be explained in the "Discussion" section at the end of this checklist.)***	**YES**	**NO**	**MAY**
a. Will the proposal require electrical power, water, or wastewater disposal, or alterations to the existing utility systems or drainage system?	☐	X	☐

DISCUSSION ***(Annotate items answered "YES" or "MAY" and provide a brief explanation of the potential impacts and mitigation measures to be implemented. Provide answers to the questions of how much, whom, where, when, and how? Contact the DPW Environmental Division at 656-2878 if assistance is needed.)***

1a. – Prescribed burn will produce products of combustion from organic material to include carbon dioxide, water vapor, carbon monoxide, particulate matter, hydrocarbons (300+), nitrogen oxides, and trace minerals that will affect air quality. Smoke management techniques are employed to minimize smoke output and disperse away from sensitive areas.

4a. – The potential for fire escape must be considered in any prescribed burn activity. However, the location of the burn unit in proximity to closest endangered or threatened species, or plant and animal critical habitat is approximately 300 meters northwest of the burn unit. Probability of fire escape is low due to firefighting resources available on site, managed fuels adjacent to the burn unit, and existing firebreaks and road network surrounding the burn unit.

8a. – Helicopters will be used in burning operations, which will increase noise and traffic for a period of one day for each operation.

SECTION 23
Attainment of Objectives

Objective (check one or more)	Measure of success (check Yes or No at completion of burn)
( ) Protect life and property during and after the burn	No one is injured, no tribal or private property is damaged, all the burn equipment is accounted for in good condition, after the burn no damage to archeological sites or other cultural resources.
	Successful? ( ) Yes ( ) No
( ) Reintroduce fire to the ecosystem	"Successful" if burn occurs or "unsuccessful" if burn does not occur.
	Successful? ( ) Yes ( ) No
( ) Reduce fuel load	Measure or estimate fuel load before and after burn. Indicate what the acceptable % overstory mortality would be.
	Successful? ( ) Yes ( ) No
( ) Reduce ladder fuel	Estimate height of understory fuel before and after burn.
	Successful? ( ) Yes ( ) No
( ) Break up fuel	Estimate cover of fuel cover before and after the burn.
	Successful? ( ) Yes ( ) No
( ) Provide seedbed	Indicate percentage of ground burned that is desired and estimate amount of cover achieved by the burn.
	Successful? ( ) Yes ( ) No
( ) WUI - reduce fuel around homes	Estimate height or distance of hazard before and after burn. Take photos.
	Successful? ( ) Yes ( ) No
( ) WUI - maintain fuelbreak	Estimate acres of fuel break burned versus target.
	Successful? ( ) Yes ( ) No
( ) Monitoring	Measurable success would be that the forms attached to the burn plan are completed and properly filed.
	Successful? ( ) Yes ( ) No
( ) Smoke management	Manage smoke emissions through best available mitigation measures. Measurable success will be both the lack of complaints and the lack of observed smoke impacting sites to be avoided.
	Successful? ( ) Yes ( ) No
( ) Other __________________	Indicate a measure of success that can be quantified.
	Successful? ( ) Yes

Appendix E: Primary Threats to Threatened and Endangered Plants Discussed in this Biolological Opinior

		Threats																			
PLANT SPECIES	**Location Multi-islands**	**Cattle**	**Deer (axis and black-tailed)**	**Goats**	**Pigs**	**Sheep**	**Rodents**	**Black Twig Borer**	**Chinese Rose Beetle**	**Two-spotted Leaf Hopper**	**Scale Insects**	**Slugs & Snails**	**Non-native Invasive Plants**	**Loss of Pollinators**	**Low Numbers of Individuals**	**Habitat Loss**	**Natural Disasters**	**Wildland Fire**	**Human Activity**	**Collection**	**Disease**
Abutilon sandwicense								●	●									●	●		
Alectryon macrococcus	●			●	●		●	●					●	●	●		●	●	●		
Bonamia menziesii	●	●	●	●	●								●					●	●		
Cenchrus agrimonioides	●	●	●	●	●		●						●					●	●		
Centaurium sebaeoides	●	●											●					●			
Chamaesyce celastroides				●	●		●	●	●			●	●					●	●		
Chamaesyce herbstii				●	●		●	●	●			●	●				●	●	●		
Ctenitis squamigera	●		●	●	●								●		●			●	●		
Cyanea grimesiana				●	●		●	●	●			●	●	●	●		●	●	●		
Cyanea longiflora				●	●		●	●	●			●	●	●			●	●	●		
Cyanea superba				●	●		●	●	●			●	●	●	●			●	●		
Cyrtandra dentata				●	●		●	●	●			●	●		●		●	●	●		
Delissea subcordata				●	●		●					●	●	●	●		●	●	●		
Diellia falcata				●	●					●			●			●		●	●		
Dubautia herbstobatae				●	●								●				●	●	●		
Euphorbia haeleeleana	●		●	●	●		●						●		●		●	●	●		
Flueggea neowawraea	●	●		●	●		●	●	●				●		●		●	●	●		
Gouania vitifolia					●		●						●		●			●	●		
Hedyotis degeneri				●	●								●		●		●	●			
Hedyotis parvula				●	●								●		●		●	●	●		
Hesperomannia arbuscula	●		●	●	●		●	●					●		●		●	●	●		
Hibiscus brackenridegei	●	●	●	●	●		●		●				●		●		●	●	●		
Lepidium arbuscula				●									●			●		●			
Lobelia niihauensis	●			●			●					●	●					●	●		
Melanthera tenuifolia				●	●		●	●	●			●	●				●	●	●		
Neraudia angulata		●		●	●		●						●		●		●	●	●		
Nototrichium humile	●	●	●	●	●								●					●	●		
Peucedanum sandwicense	●			●									●				●	●	●		
Phyllostegia kaalaensis					●								●					●	●		
Plantago princeps	●			●	●		●	●	●			●	●				●	●	●		
Pritchardia kaalae				●	●		●						●		●		●	●	●	●	●
Sanicula mariversa				●									●					●	●		
Schiedea hookeri				●	●							●	●					●	●		
Schiedea kaalae				●	●							●	●		●			●	●		
Schiedea nuttallii				●	●			●				●	●		●		●	●	●		
Schiedea obovata				●	●							●	●		●		●	●	●	●	
Silene lanceolata	●			●	●	●							●					●	●		
Spermolepis hawaiiensis	●		●	●		●	●	●	●			●	●				●	●	●		
Tetramolopium filiforme				●	●		●	●			●	●	●		●		●	●	●		
Viola chamissoniana				●	●								●		●		●	●	●		