

model (Andrews *et al* 2005) predicts long-range spotting of 1.1 km (0.8 mi), given winds of 18 mph. Therefore, spot fires are likely to ignite above the fuelbreak. Although a number of fire suppression helicopter contractors were grounded and unavailable during the Waialua Fire due to high winds generated by a nearby hurricane (Moller 2007), the Army was able to contribute two fire suppression helicopters to Waialua Fire suppression efforts (Ching 2007). If the fuelbreak had been in place at the time of the Waialua Fire, forest loss would have been minimized within the area currently designated as the Puulu to Alaiheihe Management Unit.

Although the fuelbreak's location, within critical habitat, is not ideal because it impacts critical habitat, the fuelbreak location ensures effectiveness. Approximately 52 percent of the burned management unit area is classified, by the Greenlee and Beavers (2007) pre-fire fuel model map, as forest fuels (see Figure 19). These burned forest areas, in addition to the areas which were not forested, are now dominated by guinea grass (Keir 2008). Because fires burning in cured guinea grass are more intense and spread more rapidly than fires burning in forest fuels, spot fires within these guinea grass areas may grow large (See Table PD 11 in the Makua Biological Opinion for examples of anticipated fire acreage). Plant critical habitat extends 300 to 800 m (984 to 2,625 ft) below the proposed fuelbreak's location, occupying a 92-ha (228-ac) area dominated by guinea grass. However, because multiple spot fires in a large area of guinea grass would more easily exceed the suppression capability of fire suppression resources (as noted on the Waialua Fire (Keir and Cannarella 2007)) the fuelbreak could not be situated farther downslope without sacrificing its effectiveness. The fuelbreak's location minimizes the extent of guinea grass on the upslope side of the fuelbreak, increasing the likelihood of successful spot fire containment, and reducing anticipated fire impacts to listed species and critical habitat. The fuelbreak will provide important conservation benefit to the management unit.

The Army will ensure that the fuelbreak and the ungulate exclusion fencing is constructed within three years and maintained to conserve an otherwise unprotected population of *Hibicus brackenridgei* that occurs in this area. The fencing of the Puulu to Alaiheihe Management Unit and ungulate removal will provide a long-term benefit for the *H. brackenridgei*, along with portions of six critical habitat units. Another option instead of a grazed fuelbreak would be to restore the habitat in this area to slow the spread of fire, however, at this time; the interagency conservation community is not financially equipped to fund fuel type conversion that can be very costly in an area dominated by grass. The adverse effects of grazing will reduce the conservation value of the critical habitat within the fuelbreak area but does not preclude future habitat restoration when funds and technology are available. By reducing fire threat, the proposed Puulu to Alaiheihe fuelbreak increases the suitability of the management unit area for interagency post-fire restoration efforts. The current landowner, Castle & Cooke Hawaii and current lessee Flying R Ranch are supportive of additional interagency efforts to conserve listed species and critical habitat on their land (Takemoto 2008).

General Effects of Fire Retardant and Foam Use

As described in the Project Description of the Makua Biological Opinion, the Army and partner fire suppression agencies may add foam and fire retardant chemicals to water to increase the effectiveness of fire suppression engines and helicopters. Based on a review of the best available scientific literature, most plants are not directly affected by this action. However,

construction. *Hibiscus brackenridgei* ssp. *mokuleianus* seedlings may germinate in the fuelbreak area where grass competition will be reduced, but these plants would not persist due to herbivory from the domestic livestock. However, the loss of the *H. brackenridgei* ssp. *mokuleianus* individuals in the grazed fuelbreak area will be offset by the exclusion of ungulates from the 210-ha (519-ac) management unit that will allow for the natural regeneration of seedlings free from grazing pressure. During fire suppression operations within and outside the action area, chemical fire retardant or foam additives which may be broadcast onto *H. brackenridgei* ssp. *mokuleianus* plants may adversely impact individual plants (see general effects section). Although it is not anticipated because it has not been observed in intensive historic monitoring (U.S. Army Garrison 2005, 2006, 2007), plants in areas where grass is intensively managed either with herbicide or mechanical means may be negatively impacted by the herbicide or may be inadvertently trampled or pulled up by Army Natural Resources Staff.

Conclusion

As a result of the 2007 Waialua Fire, the status of *Hibiscus brackenridgei* ssp. *mokuleianus* substantially declined (see Table 3). Despite the ongoing exposure to the Army's potential wildland fire impacts, Army conservation and stewardship programs will improve the baseline condition for this species in the action area and range-wide. Weapons restrictions, fuel management, fire suppression, invasive species control, and expedited stabilization actions over the next 30 years will increase baseline numbers of *H. brackenridgei* ssp. *mokuleianus* in four population units, including two outside the action area which will not be vulnerable to training-related wildland fire. 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. The construction of the Puulu to Alaiheihe Management Unit and fuelbreak will benefit this species by reducing the threat of future wildfire in this area and enhancing habitat for natural recruitment of this species. Based on our analysis of the effects of the actions outlined in the Makua Biological Opinion and this Amendment including fire minimization measures, the Service believes that the risks associated with the Army's proposed action are outweighed by the long-term benefits from the Army's expedited *H. brackenridgei* stabilization actions and ecosystem management.

Effects of the Action on *Hibiscus brackenridgei* Critical Habitat

In total, the training and fuelbreak portions of the action area contain two percent of all range-wide critical habitat designated for *Hibiscus brackenridgei*. Critical habitat unit C is a 0.04 ha or 0.1 ac sliver of land within the high fire risk zone at Makua and the Puulu to Alaiheihe fuelbreak portion of the action area contains six percent (35 ha (86 ac) of *H. brackenridgei* critical habitat unit B. In both portions of the action area, the *H. brackenridgei* critical habitat is heavily disturbed and currently dominated by invasive, exotic grasses (Hawaii Gap Analysis Program 2005 and Keir 2008) thereby degrading the vegetative primary constituent elements of the critical habitat.

Training Effects Less than one percent of the total critical habitat for *Hibiscus brackenridgei* is found in one unit within the training portion of the Makua action area (see Figure 17). The small critical habitat sliver is located entirely within the high fire risk area. 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 critical habitat in this area contains less than 25 percent native plant cover, indicating that this unit is predominantly characterized by non-native vegetation (Kawelo 2004; 68 FR 35950). 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 out-compete the native plants. 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. Currently, the Army conducts fuel modification in the immediate habitat area of the *H. brackenridgei* var. *mokuleianus* plants, which will reduce the risk of fire and enhance the conservation value of this adjacent critical habitat 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. While there may be a temporary 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 *Hibiscus brackenridgei* will not be diminished, in the long term, by the proposed action.

Puulu to Alaiheihe Fuelbreak Effects The Puulu to Alaiheihe fuelbreak portion of the action area contains six percent (35 ha (86 ac)) of *Hibiscus brackenridgei* critical habitat unit B. With the exception of a small sliver along its eastern edge, the entire fuelbreak action area is designated critical habitat for *H. brackenridgei* (Figure 24).

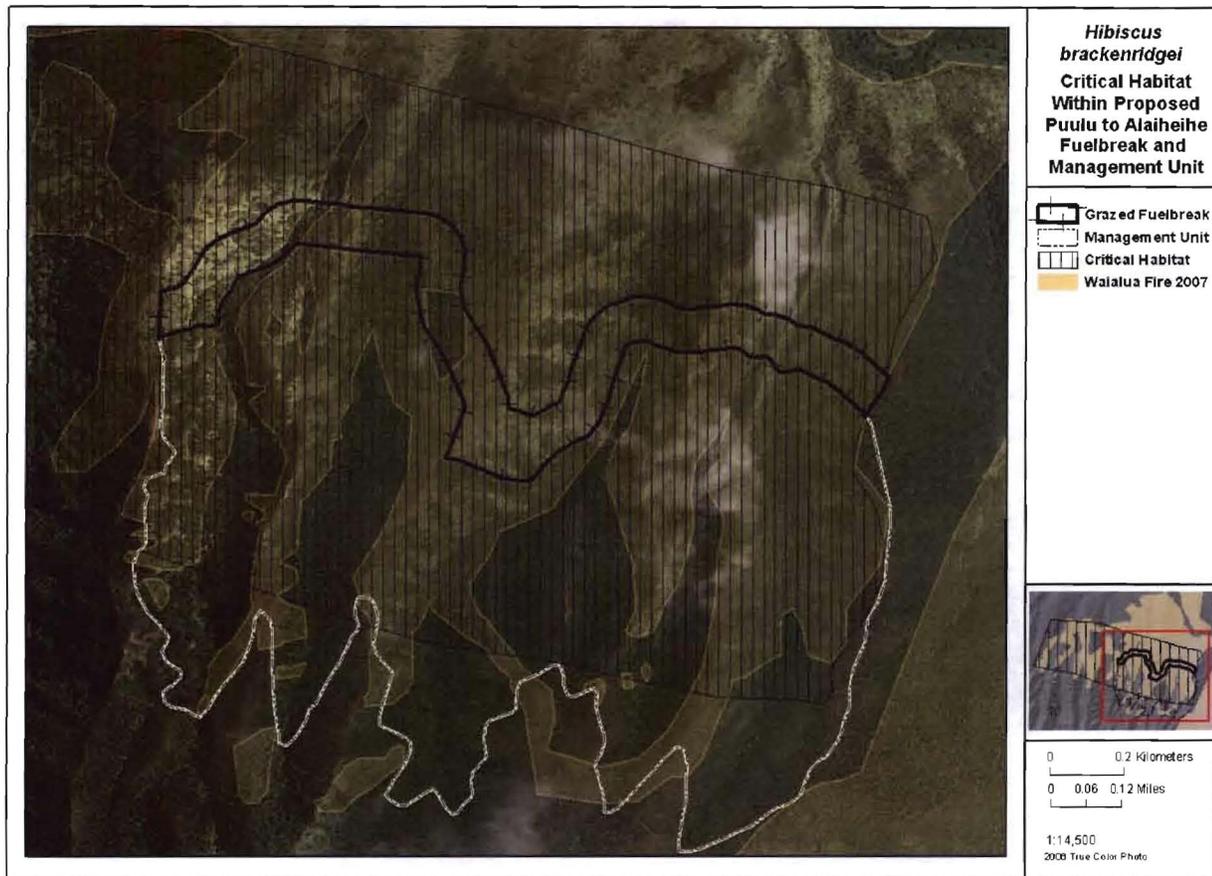


Figure 24. *Hibiscus brackenridgei* critical habitat in vicinity of the Puulu to Alaiheihe fuelbreak.

Like the *H. brackenridgei* critical habitat found in the training portion of the action area the site is dominated by invasive, exotic grasses as a result of historic and ongoing grazing and fire impacts (Gap Analysis Program 2005 and Keir 2008). The proposed fuelbreak will minimize fire risk to the 28 percent (159 ha (392 ac)) of the 560-ha (1385-ac) *Hibiscus brackenridgei* critical habitat unit B that occurs within the Puulu to Alaiheihe Management Unit.

Approximately 44 percent (104 ha (258 ac)) of unit C was burned in the Waiialua Fire (see Figure 24). Army fire suppression protection to the Makua, Puulu to Alaiheihe, and Haili to Kawaiu *H. brackenridgei* population units will reduce fire impacts to co-occurring areas of critical habitat. In addition to reducing fire threat, the Army is enhancing the conservation value of critical habitat within the Puulu to Alaiheihe Management Unit and in the vicinity of the Haili to Kawaiu *H. brackenridgei* population unit by excluding ungulates and, to varying extents, controlling non-native invasive weeds.

Conclusion

In total, the two portions of the action area contains two percent of all range-wide critical habitat designated for *Hibiscus brackenridgei*. In both portions of the action area, the *H. brackenridgei* critical habitat is heavily disturbed and currently dominated by invasive, exotic grasses (Hawaii Gap Analysis Program 2005 and Keir 2008). Implementation of all fire suppression and fuel management measures incorporated into this action and the Army's

project description 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, even though there may be a temporary loss of shrubs within critical habitat unit C due to a training-related fire, the restoration of this area by the Army will prevent the loss, due to Army actions, of habitat essential for the conservation of *H. brackenridgei* var. *mokuleianus* and provide for the long-term recovery goals of this species. The Army's proposed Puulu to Alaiheihe fuelbreak, and ungulate removal and fire suppression protection to the Puulu to Alaiheihe Management Unit will conserve 159 ha (392 ac) of critical habitat unit B. In the absence of proposed Army actions, the primary constituent elements of this portion of the critical habitat unit would continue to be degraded as a result of exposure to threats such as ungulates, fire, and non-native plant encroachment. Therefore, training-related fire events and the proposed fuelbreak will not result in adverse modification of critical habitat for *H. brackenridgei*.

Effects of the Action on *Nototrichium humile* Critical Habitat

The action area contains a total of slightly more than one percent of the total critical habitat for *Nototrichium humile* on Oahu, including 6 ha (16 ac) within the training portion of the action area and 7 ha (17 ac) within the proposed Puulu to Alaiheihe fuelbreak.

Training Effects Effects of the proposed action to the one percent of *Nototrichium humile* critical habitat that occurs within the training portion of the action area as described in the Makua Biological Opinion remain valid. In summary, critical habitat unit A is a total of 5 ha (13 ac), located almost entirely within Kaluakauila Management Unit and is exposed to high risk of training-related fire. Less than one percent (1 ha (3 ac)) of the 229-ha (567-ac) critical habitat unit B overlaps with the very low fire risk zone on the east edge of the training action area. Based on historic fire perimeter maps, Unit A was within the perimeter of 1970 and 1984 fires ignited by the military at Makua (Costales 2006). Approximately 30 percent of critical habitat unit A was impacted by the 2003 escaped prescribed burn at Makua (Enriques 2003). 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 training-related fire will be reduced due to the construction of a fuelbreak between the impact area and critical habitat unit A, within Kaluakauila Management Unit. In addition, even though there may be a temporary loss of vegetation due to training-related fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *N. humile* and promote long-term recovery of this species.

Puulu to Alaiheihe Fuelbreak Effects Three percent (7 ha (17 ac)) of the 237-ha (586-ac) *Nototrichium humile* critical habitat unit C is located within the proposed Puulu to Alaiheihe fuelbreak. Impacts of grazing management of the fuelbreak area are described in the general effects section of this Amendment. In summary, prescribed intensive grazing will minimize hardwood seedlings establishment, deplete the hardwood soil seed bank, and result in an increase in cover of invasive grass. Because hardwood species are among the primary constituent elements of critical habitat for *N. humile*, fuelbreak maintenance will result reduced conservation value of this portion of the critical habitat unit. Ninety-seven percent of *N. humile* critical habitat in the fuelbreak portion of the action area was classified as alien

vegetation (Hawaii Gap Analysis Program 2005), it is currently actively managed as a pasture for cattle and goats (Cherry 2008) and all of it was burned in the Waialua Fire (Figure 25).



Figure 25. *Nototrichium humile* critical habitat in the Puulu to Alaiheihe Gulch area.

The proposed fuelbreak will minimize fire risk to the 67 percent (159 ha (392 ac)) of the 237-ha (586-ac) *Nototrichium humile* critical habitat unit C that occurs within the Puulu to Alaiheihe Management Unit. Approximately 44 percent (104 ha (258 ac)) of unit C was burned in the Waialua Fire (see Figure 25). In addition to reducing fire threat, the Army is enhancing the conservation value of critical habitat unit C by excluding ungulates and controlling non-native invasive plant species within the Management Unit.

Conclusion

Nototrichium humile critical habitat unit A and one percent of unit B are located within areas at risk of training-related fire in the Makua action area and three percent of critical habitat unit C is located in the Puulu to Alaiheihe fuelbreak portion of the action area where it will be impacted by grazing. Implementation of all fire suppression and fuel management 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, the portion of critical habitat unit A that is within Kaluakauila Management Unit will be managed to improve its baseline quality pursuant to the Makua Implementation Plan. Most importantly, even though there may be a temporary

loss of vegetation due to training-related fire, the restoration of these areas by the Army will provide habitat essential for the conservation of *N. humile* and promote long-term recovery of this species. Prescribed intensive grazing management of the Proposed Puulu to Alaiheihe fuelbreak will temporarily reduce the establishment of shrubs and trees within one percent of critical habitat unit C. However, fuelbreak establishment and Army ungulate exclusion efforts will minimize fire risk to the 67 percent of critical habitat unit C that is within the Puulu to Alaiheihe Management Unit. Without Army management, critical habitat units A and C 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, fires ignited by the public 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. Therefore, training-related fire events and impacts of the proposed fuelbreak will not result in adverse modification of critical habitat for *N. humile*.

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 Amendment. 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.

Hibiscus brackenridgei and plant critical habitat in the training and fuelbreak portions of the action area are likely to be exposed to stressors associated with fires ignited by local arson incidents or by public carelessness. 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 burned over approximately 2,327 ha (5,750 ac) in the Waianae area (Waianae Valley, Waianae, Maili, and Lualualei) and 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 (State of Hawaii Department of Land and Natural Resources 2007). One such fire in July 2006, spread into the Lower Okikilolo Management Unit of Makua, where it burned within 150 m (495 ft) of *H. brackenridgei* ssp. *mokuleianus* plants (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 genetic storage reintroductions of *H. brackenridgei* ssp. *mokuleianus* (U.S. Army Garrison 2006d). The August 2007 Waialua Fire, burned 2,268 ha (5,606 ac) within and adjacent to the Puulu to Alaiheihe fuelbreak portion of the action area.

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 *Hibiscus brackenridgei* in the action area from

feral ungulates as a result of State regulated hunting activities in Forest Reserves and Game Management Areas.

CONCLUSION

After reviewing the current status and environmental baseline of *Hibiscus brackenridgei*, critical habitat for *Abutilon sandwicense*, *Bonamia menziesii*, *Eugenia koolauensis*, *Euphorbia haeleeleana*, *H. brackenridgei* and *Nototrichium humile*, and the effects of military actions in the action area (Makua and the Puulu to Alaiheihē Management Unit/fuelbreak), including the cumulative effects, it is our biological opinion that implementation of the proposed action is not likely to jeopardize the continued existence of *H. brackenridgei* or adversely modify or destroy designated critical habitat for the six plant species addressed in this Amendment.

The non-jeopardy conclusion is based on the following: (1) a risk assessment regarding the potential of a fire igniting and burning plants; (2) 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; (3) weapons restrictions, fuels management, fire suppression, and construction of fuelbreaks and firebreaks will minimize the risk of wildland fire within and outside the action area; and (4) Army invasive species control including ungulate removal and invasive plant management.

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 should develop and implement daily fire suppression helicopter staffing protocols to ensure the interagency and Army-funded fire suppression force is adequate to protect the Army's stabilization population units, particularly when live herbaceous fuel moisture is below 120 percent at the Makua Range weather station.
- 2) The Army should maintain cooperative agreements with Hawaii County and the State of Hawaii to ensure Army fire suppression resources are able to assist with fire suppression efforts, as necessary, on a case by case basis, to protect the *Hibiscus brackenridgei* populations on the island of Hawaii from fire.
- 3) 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.

- 4) To facilitate reintroduction, fire suppression, and fuelbreak planning, Army Natural Resources Staff should add GPS locations of individual plants to their GIS database.
- 5) The Army should hire a fuels management specialist to coordinate the expedited development of Waianae Mountains fuelbreaks, supervise the fire suppression operations of the Army Natural Resource Staff, assist the Army with the development and maintenance of cooperative agreements with interagency fire suppression organizations, and to coordinate fuel moisture and fire behavior research and data collection. This person should be qualified as a National Wildfire Coordinating Group Incident Commander Type 4, should be certified as a single resource boss, and should have completed S-490 (Advanced Fire Behavior) and/or S-491 Intermediate National Fire Danger Rating System.
- 6) The Army should aggressively pursue acquisition and transfer of title to a public or private conservation organization, of the Puulu to Alaiheihe Gulch and Haili to Kawaiu areas to better ensure access for long-term Army stabilization actions. This could be accomplished through the Army Compatible Use Buffer program.
- 7) The Army should establish protocols for hydro-mulching or other large-scale native plant seeding to be used in native habitat restoration efforts.
- 8) 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.
- 9) In order to substantially reduce the fire risk associated with live-fire training, the Army should 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 at the Makua Range weather station.

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 non-jeopardy 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. References not previously cited in the Makua Biological Opinion are enclosed. If you have any questions regarding this Amendment, please contact Dawn Greenlee at (808) 792-9400.

Sincerely,

A handwritten signature in black ink that reads "Patrick Leonard". The signature is written in a cursive, flowing style.

for Patrick Leonard
Field Supervisor

Enclosure:

References not previously cited in the Makua Biological Opinion

**REFERENCES NOT PREVIOUSLY CITED
IN THE MAKUA BIOLOGICAL OPINION**

- Alexander, M.E.C. Tymstra and K.W. Frederick. Incorporating breaching and spotting considerations into Prometheus - the Canadian wildland fire growth model. Chisholm/Dogrib Fire Research Initiative, Quicknote 6, 2 pp.
- Andrews, P.L. 1986. BEHAVE: fire behavior prediction and fuel modeling system - burn subsystem, Part 1. U. S Forest Service, Intermountain Forest Research Station, Ogden, Utah, General Technical Report INT-194, 130 pages.
- Beachy, Jane. 2007. Meeting during Waialua Fire field survey, Waialua, Hawaii. August 29-30, 2007.
- Beavers, A. 2008. Center for Environmental Management of Military Land, U.S. Army Garrison Hawaii contractor. Telephone conversation. May 14, 2008.
- Bell, T. 2003. Effects of fire retardants on vegetation in eastern Australia heathlands: a preliminary investigation. Research Report No. 68, Fire Management, Department of Sustainability and Environment, Victoria, Australia. 41 pp.
- Bradstock, R.A., J. Sanders and A. Tegart. 1987. Short term effects on the foliage of a eucalyptus forest after an aerial application of a chemical fire retardant. Australian Forestry 50(2): 71-80.
- Castillo. J.M., A. McAdams, M. Nakahara, D. Weise, and G. Enriques 2006. Effects of prescribed grazing and burning treatments on fire regimes in alien grass-dominated wildland-urban interface areas, leeward Hawaii. Final Report to the Joint Fire Science Program. Project No. 01-3-4-14. 97pp.
- Cherry, Robert. 2008. Rancher, Meeting at Flying R Ranch, Waialua, Hawaii (February 26, 2008).
- Ching, Susan. 2008a. U.S. Army Garrison, Hawaii, Natural Resource Staff, Implementation Plan Project Coordinator. Telephone interview. May 15, 2008.
- Ching, Susan. 2008b. U.S. Army Garrison, Hawaii, Natural Resource Staff, Implementation Plan Project Coordinator. Meeting at Army Baseyard, Wheeler Army Airfield, Hawaii. May 7, 2008.
- Ching, Susan. 2007. U.S. Army Garrison, Hawaii, Natural Resource Staff, Implementation Plan Project Coordinator. Meeting at Army Baseyard, Wheeler Army Airfield, Hawaii. August 30, 2007.
- Giambelluca, T.W., Nullet, M.A., and Schroeder, T.A. 1986. Hawaii Rainfall Atlas, Report R76, Hawaii Division of Water and Land Development, Department of Land and Natural Resources, Honolulu, vi 267p., Digitized by the Office of Planning.

Enclosure for Amendment of the Makua Biological Opinion (June 2008)

Greenlee, D. and A. Beavers. 2007. Fuel Model Map for Makua Action Area and Vicinity. Unpublished.

Greenlee, Dawn (Fish and Wildlife Biologist, U.S. Fish and Wildlife Service) in partnership with Jane Beachy, Susan Ching, Kapua Kawelo, Matt Keir, Jobi Rohrer (U.S. Army Natural Resources Staff); Mark Takemoto Castle & Cooke Natural Resources Administrator; Andy Beavers (Fire Ecologist, Center for Environmental Management of Military Lands); Robert Cherry (Flying R Ranch, Waialua, HI), Randall Kennedy, Ryan Peralta, Ruben Mateo, and Talbert Takahama (Hawaii Department of Land and Natural Resources); Greg Koob, Oahu District Conservationist Chad Kacir, and State Rangeland Management Specialist Loretta Metz (U.S.D.A Natural Resource Conservation Service); and Marie Bruegmann and Jeff Zimpfer (Fish and Wildlife Biologists, U.S. Fish and Wildlife Service). October 29, 2007.

Greenlee, J. 2007. Unpublished document: Spot Fires in Guinea Grass (*Panicum giganteum*), a Hazardous Fuel in Hawaii. 15pp.

Hawaii Gap Analysis Program. 2005. HI-GAP statewide land cover GIS layer.

Hirsch, S. N., G. F. Meyer and D. L. Radloff. Choosing an activity fuel treatment for southwest ponderosa pine. U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO., 15 pages.

Hough, W.A. and F.A. Albini. 1978. Predicting fire behavior in palmetto-gallberry fuel complexes. U.S. Forest Service, Southeastern Forest Experiment Station, Research Paper SE-174, 48 pages. Citation 34455.

Kacir, Chad. U.S.D.A. Natural Resource Conservation Service (NRCS). Meeting at NRCS Office, Aiea, Hawaii. September 5, 2008.

Kayll, A.J. 1968. Heat tolerance of tree seedlings. Tall Timbers Fire Ecology Conference 8:89-105.

Keir, Matthew. 2008. U.S. Army Natural Resource Management Rare Plants Program Manager. Meeting at Army Baseyard, Wheeler Army Airfield, Hawaii. January 17, 2008.

Keir, Matt. U.S. Army Garrison, Hawaii Rare Plants Program Coordinator and Ronald Cannarella, Hawaii Department of Land and Natural Resources. 2007. Waialua Fire Perimeter Map: Joint effort, drafted originally during the Waialua Fire by U.S. Army Garrison Natural Resources Staff. Flown via helicopter by Ronald Cannarella, who transferred GPS and video information to map with assistance from Dawn Greenlee (U.S. Fish and Wildlife Service). (Field surveys and GIS work completed, primarily by U.S. Army Natural Resource Staff. September 10, 2007).