

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 Garrison 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 Implementation 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.

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 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.

Status of Critical Habitat in the Action Area 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).

Threats to the Species and Critical Habitat in the Action Area 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).

Threats to the Species 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

Status of the Critical Habitat in the Action Area 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).

Threats to the Critical Habitat in the Action Area 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).

Ongoing Conservation Actions for the Critical Habitat Within the Action Area 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)

Species Description *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 enclosures. 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 [‡]	8/2	7/9
West Makaleha*	--	--	7	[14/19] [§]	[15/15]	[24/2]
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]
Palikeya Gulch	--	--	1	0/1	0/1	0/1
Palikeya (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. *obatae* 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.

Conservation Needs of the Species 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.

Ongoing Conservation Actions 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 enclosures. Reintroductions within the North Branch of South Ekahanui population unit are within the management unit fence, although the naturally occurring

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).

Critical Habitat Description 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 waianaensis*, *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 enclosure 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 enclosure 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*

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

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 Pupukeya-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.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area 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 enclosure (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)

Species Description *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).

Listing Status 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).

Historic and Current Distribution *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 stabilization (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 molluscicide 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.

Conservation Needs of the Species 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.

Ongoing Conservation Actions 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)

Species Description *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).

Listing Status *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).

Historic and Current Distribution *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, Opaepala 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*.

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

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 Opaepa. 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*

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

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 one 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 enclosures. 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.

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 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.

Status of Critical Habitat in the Action Area 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).

Threats to the Species and Critical Habitat in the Action Area 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 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 (Agurauja and Wood 2002, 2003; Agurauja 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) Agurauja and Wood. 2002

(4) Critical Habitat (68 FR 35950)

(5) Agurauja 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 grow on soil that is rocky, granular and usually dry, with some leaf litter and mosses (Agurauja 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). Agurauja 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 (Agurauja 2001, Agurauja 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 (Agurauja 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 area, 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)

Ecology *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.

Threats to the Species *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.

Conservation Needs of the Species 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* bear 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).

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 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 enclosure. 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.

Status of the Critical Habitat in the Action Area 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).

Threats to the Species and Critical Habitat in the Action Area 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 haelealeana* 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 to 14 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 <i>ex/inter situ</i> 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 enclosures; 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.

Ongoing Conservation Actions 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).

Critical Habitat Description 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.

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 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

Status of Critical Habitat in the Action Area 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 enclosure. 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 individuals 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			
*Alaiheihē 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).

Ongoing Conservation Actions 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 schlechtendahlana*, 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).

Critical Habitat Description 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*.

Population Units	Number of Known Individuals					
	1991 (1)	1995-1998 (2)	2003 (3)	2004 (4)	2005 (5)	2006 (6)
Ohikilolo Makai*	--	150	50	78/12	79/29	120/68
Ohikilolo Mauka*	--		17			
East Makaleha*	--	--	--	--	--	--
Halona & Palikea Ridge*	--	60-75	64-79	12/0	87/47	87/28
Palawai	--	10	0	0	0	0
Other Locations						115
Total Individuals	--	220-235	131-146	102 (90/12) [†]	242 (166/76)	418 (322/96)

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 *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.

Threats to the Species *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 needs 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.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area 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)

Species Description *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 Kawaii 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).

Listing Status *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 Kawaii*	--	--	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 moths. 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).

Critical Habitat Description 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 amplexans*, *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).

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 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 – *Isodendron laurifolium* (Aupaka)

Critical Habitat Description A total of 1,757 ha (4,342 ac) of critical habitat was designated for *Isodendron 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; Mokeleia, 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 *Isodendron 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).

Ongoing Conservation Actions for the Critical Habitat Within the Action Area 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 enclosures 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 – *Isodendron longifolium* (Aupaka)

Critical Habitat Description A total of 2,127 ha (5,255 ac) of critical habitat has been designated for *Isodendron 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).

Threats to the Critical Habitat 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

Status of the Critical Habitat in the Action Area Less than one percent, 0.5 ha (1 ac), of the designated critical habitat for *Isodendron 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-Keau Ridge, Kapuhi Gulch, and Manini Gulch, Pahoia 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 of *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.

Ongoing Conservation Actions for the Species 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)

Species Description *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)

Listing Status *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).

Historic and Current Distribution 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 enclosures 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.

Historic and Current Distribution *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)

Ecology *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 stabilization. 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).

Threats to the Species and Critical Habitat in the Action Area 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.

Conservation Needs of the Species and Critical Habitat in the Action Area 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.

Ongoing Conservation Actions for the Species and Critical Habitat in the Action Area 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 enclosure 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 through 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).

Ongoing Conservation Actions 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).

Critical Habitat Description 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.

Status of the Critical Habitat in the Action Area 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.

Threats to the Species and Critical Habitat in the Action Area 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.

Conservation Needs of the Species in the Action Area 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.

Ongoing Conservation Actions for the Species in the Action Area 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
Kaluakauila*	--	--	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 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), 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